N72-17969

STARSITE

TOWARD A DECISION MAKING MECHANISM FOR HOUSING

FINAL REPORT

1971 NASA-ASEE
SUMMER FACULTY FELLOWSHIP PROGRAM
IN SYSTEMS ENGINEERING DESIGN
MARSHALL SPACE FLIGHT CENTER
AUBURN UNIVERSITY
JANUARY 11, 1972
NASA GRANT NO. NGT 01-003-044
NASA CR-61371

SCHOOL OF ENGINEERING
AUBURN UNIVERSITY
AUBURN, ALABAMA
36830

NOTE

The information in this report represents the views of the engineering systems design program participants and does not necessarily reflect the views or policy of NASA, or those of any other Government agency or private corporation.

STARSITE

Search to Assess Resources, Social, Institutional, Technical, and Environmental

Toward a Decision-Making Mechanism for Housing

FINAL REPORT

Prepared Under

GRANT NGT 01-003-044
HEADQUARTERS OFFICE OF UNIVERSITY AFFAIRS
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

with the cooperation of

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

and

PROGRAM DEVELOPMENT
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

by

AUBURN UNIVERSITY ENGINEERING SYSTEMS DESIGN
SUMMER FACULTY FELLOWS

JANUARY 1972

APPROVED:

Reginald I. Vachon
Alumni Professor, Auburn Univ.
Director

Herman G. Hamby
MSFC, Program Development
Co-Director

J. Fred O'Brien
Associate Director
Engineering Extension
Service
Auburn University
Associate Director

Russell E. Lueg
Professor, Univ. of Alabama
Associate Director

William R. Payne
MSFC, Program Development
Associate Director

Page Intentionally Left Blank

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Concluded)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

LIST OF ILLUSTRATIONS (Concluded)

LIST OF TABLES

ABSTRACT

"If NASA can put a man on the moon, why can't they----

a. Solve the transportation problem

b. Handle the power crisis

c. Cure the pollution problem

-- --------------- --."

You have heard these phrases many times over the past several years. The speaker, whether a congressman, electrician, or a housewife, simply appends a pressing problem and awaits its results.

NASA's impressive success in realizing its challenge to put a man on the moon and bring him back safely has created awe and frustration in the mind and soul of man as he tackles the problems of life. Why can't the management techniques used to accomplish a fantastic technological feat be directed toward solving the problems of man as the question posed in the phrase "if NASA can --------------." All of the problems mentioned are people-oriented problems, and, although involving hard technology, are not hardware-oriented problems.

This report presents the results of 20 senior faculty who spoke the phrase in relation to housing and applied the systems approach technique, an aerospace management technique, to housing. This report reflects the application of the systems approach to define the housing problem and suggests that a model of the housing system as it exists should be developed to understand the housing problem and provide a point of beginning for examining possible changes in the system for the benefit of man.

The significance of this report is evident when viewed in conjunction with the work of Jay W. Forrester of MIT who has presented the quality of life versus time in his book World Dynamics as shown in Figures A-1, A-2, and A-3. Figure A-1 shows present trends of linearly increasing capital investment with apparent prosperity except that population growth more than absorbs this prosperity and the quality of life declines. Figure A-2 shows that accelerated capital investment creates prosperity and pollution. The quality of life and population take a sharp drop of catastrophic proportion from about 2020 to 2050 as population growth overburdens life-support systems. Figure A-3

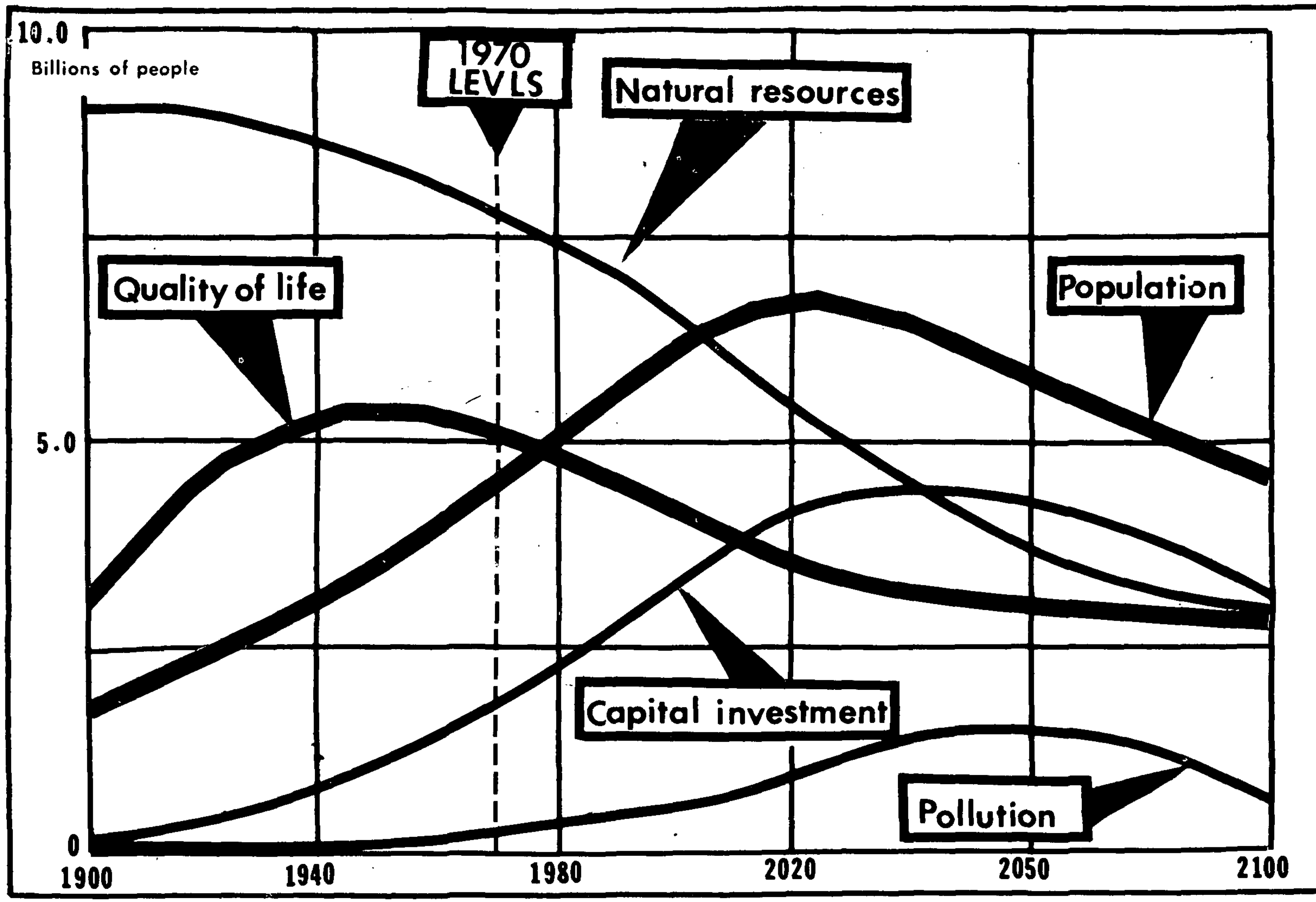


Figure A-1. Present trends of quality of life — population growth absorbs apparent prosperity and quality of life decline.

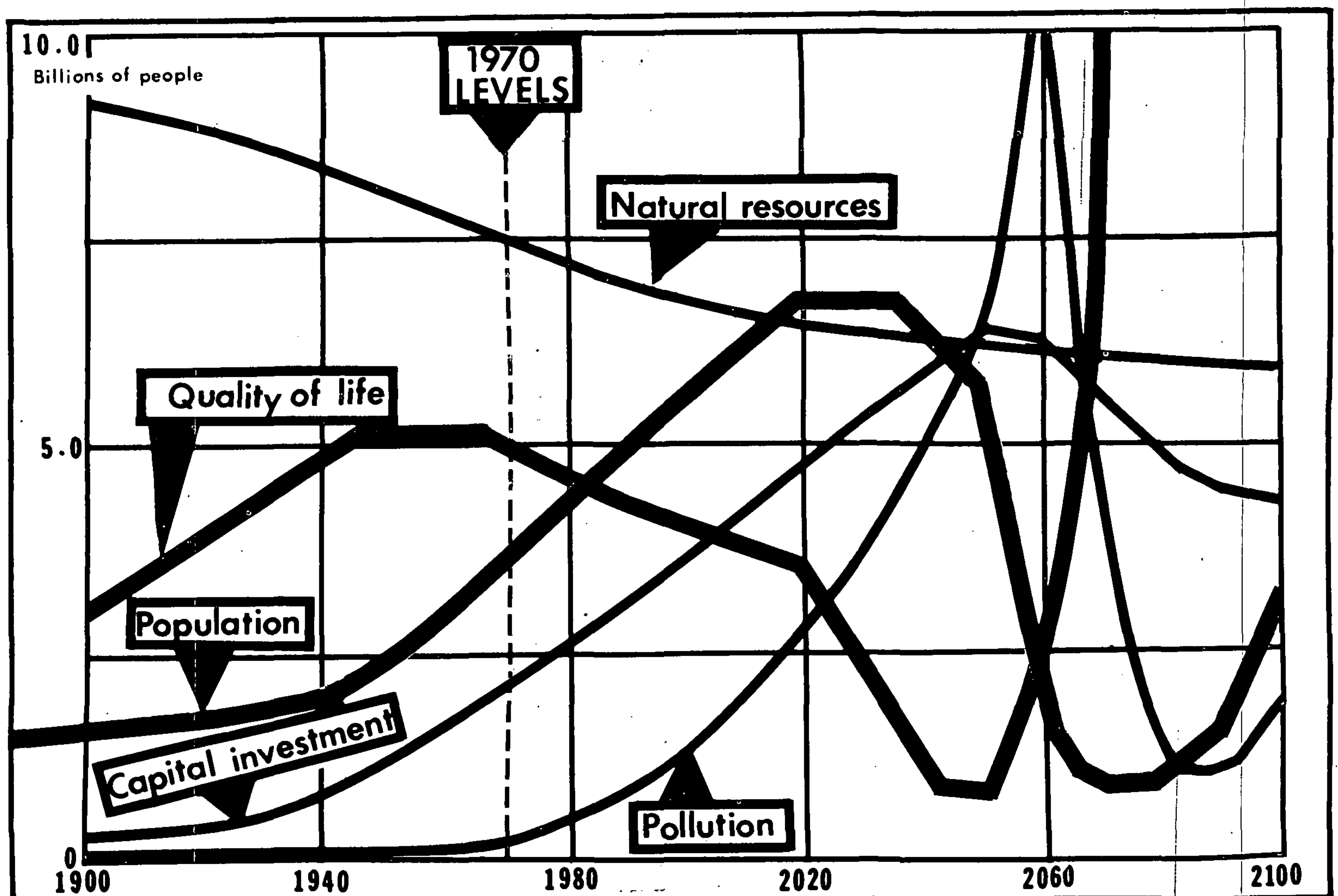


Figure A-2. Possible trend of quality of life — accelerated investment creates prosperity and pollution with quality of life catastrophy in Year 2020.

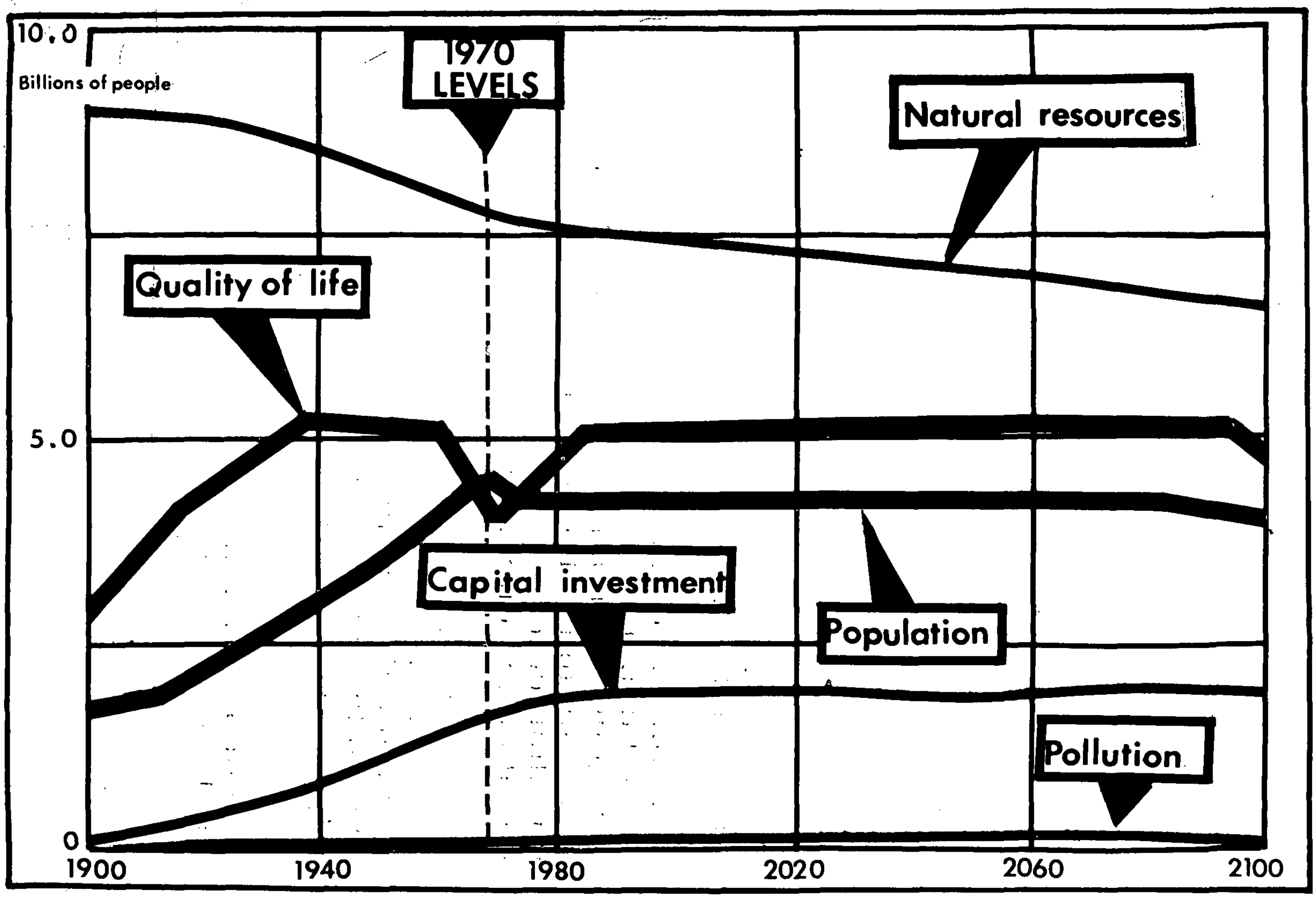


Figure A-3. Rational quality of life — stable investment and population results in stable quality of life.

portrays stable capital investment and stable population which result in a stable quality of life. Housing and the many aspects of housing affects the quality of life and are affected by the quality of life. This report reflects the effort to develop a decision-making mechanism for housing, thus enabling decisionmakers to look at the effect of housing on the quality of life.

The systems approach was used and the result is best summarized by one of the participants who spoke at the final presentation of the group on August 18, 1971. His comments are:

> "For us this summer produced a happening and a document. The previous speakers have, for the most part, described the contents of the document. It is my task to briefly summarize the happening.
>
> Before doing this, however, it is useful to look at the document. The report describes an approach to model-making and the rational modeling for decisions in the housing system. The report attempts to bring to the surface the complexities of the housing system. Most importantly, an attempt is made to identify the several elements of the system and the interaction between them. As such, the report might be viewed as the presumptuousness of a group of academic technologists. Certainly we are not expert in the elements of the housing system. It is my purpose here, however, to demonstrate how we came to do what we did and perhaps to demonstrate its validity as a beginning.
>
> To begin with the staff of the project showed an uncanny sense of perspective in choosing consultants to give testimony to our group. The consultants came from many elements of the housing system. From their reports to us, one could conclude that the housing system is like the legendary hydra, a beast of many heads, each seemingly fiercer than the rest and all trying to devour the poor common man. Most of the consultants had, however, drawn a bead on the heart of the beast. Unfortunately, the beast appears to have at least as many hearts as it has heads.
>
> It soon became clear that the beast was not the proverbial hydra at all, but rather it was more like the proverbial elephant as reported by the four blind men. In general, perspective of the beast is very easily lost if you have worked hard on one

of its elements, and the system is ponderous also, like an elephant. What we have tried to do is to write about how to describe and train an elephant — and not how to kill the hydra. It is a book about elephants written by the butcher, the baker, and the candlestick maker, not by zoologists.

The path to our point of view was not unlike that of John Bunyon's Pilgrim. We came, in fact, to the Slough of Despond about three and a half weeks ago. At that time we looked at our kind of tools. It was very much lacking. We simply were not experts. We perhaps had a pretty good overview — collectively. But, we had few real skills for solving the immediate problems in housing. On top of this, we were not sure that a problem existed; or that if it existed, it could be measured; or that any solution could be implemented. We saw two paths to take. One would have employed our available skills on a portion of the system. In this context, the variable alternatives house and new cities were being considered. The other path led toward a set of guidelines for the whole system. It appeared that the outcome of the first path could lead to little of impact in areas already under broad study. The other choice appeared to be leading to another report about housing. At that time, by our infinite wisdom (we are professors, you know) we chose the second path. (Actually, we had a hung vote and moved to the broader base partially in exasperation.)

Getting back to the Slough, we saw then that not only were we inexpert, but that we had little chance of gaining expertise. The literature pertaining to the elements of the housing system is seemingly endless. Further, the system itself appears to be undergoing a very rapid change, and it is difficult to keep abreast if you are not in the current. And then, only part of the needed information is available anywhere.

But, perhaps, this really points up the contribution we are trying to make; that is, that a new expertise needs to be developed — an expertise on the housing system as a system. In its first stages, this new expertise would have only a rudementary understanding of the system's elements, but would try to judge their basic character, and it would try to see how the elements connect to each other and how they can be manipulated to make the housing system function in a rational way."

PREFACE

Program Description

The National Aeronautics and Space Administration (NASA) and the American Society for Engineering Education (ASEE) have sponsored faculty fellowship programs in Systems Engineering Design for the past several years. NASA, having used and developed this systems approach and realizing its general usefulness, has shared its experience with the educational community through Summer Faculty Fellowship Engineering System Design Programs conducted jointly by a NASA center and a cooperating university. Four such programs were conducted during the summer of 1971:

- Marshall Space Flight Center — Auburn University.
- Langley Research Center — Old Dominion College.
- Manned Spacecraft Center — University of Houston.
- Ames Research Center — Stanford University.

The George C. Marshall Space Flight Center (MSFC), Auburn University, and the University of Alabama conducted two systems design programs in 1967 and 1969, and MSFC and Auburn University conducted the 1970 program and MSFC and Auburn conducted the present program conducted herein.

Each program uses a real-world training exercise to give the approximately 20 faculty participants an opportunity to test the approach and live through and evaluate the group dynamics of the effort. The training exercise has an added advantage in that each center and NASA, through sharing the support of the programs, benefit from interaction with the faculty. The result of the training represents an unbiased study and opinion on a topic of interest to NASA. Each participant then carries this experience to his home institution where either he may develop class projects that use a similar approach, or he, with others, may select a project to involve faculty and students to solve a real problem using this approach. An outstanding example of spin-off is the program conducted during the summer of 1971 by graduates of the MSFC-Auburn-Alabama 1969 and 1970 programs. Dr. Ordean Anderson and Prof. Mel Forthun of North Dakota State University and Dr. Denny Mathiason of Moorhead College and Dr. Duane Dahlberg of Concordia College

conducted a systems approach, faculty summer program applied toward development of the Red River Basin of the North. This program is patterned after their experiences in 1969 and 1970 at MSFC. This project, funded by the Office of Water Resources, shows a concrete result of involvement with NASA and demonstrates spin-off of a technique from NASA applied to the civilian economy. Dr. Anderson and the others have stated that without the 1969 and 1970 experiences, their project would have been next to impossible.

The Systems Approach

The systems approach has been adopted as a more general terminology than systems engineering to describe the philosophical approach and view to the solution of complex multidisciplinary problems. The definitions given to the systems approach are as many as the definitions of beauty, which exists in the eye of the beholder. Two encompassing definitions for consideration are: (1) "the solution of a complete problem in its full environment by systematic assembly and matching of parts to solve the whole problem, in the context of the lifetime use of the system or plan, considering all aspects";[1] or (2) an optimal solution or strategy to a complex multidisciplinary problem. Figure 1 shows the steps involved in the systems approach procedure and emphasizes the four steps of the approach: (1) translation, (2) analysis, (3) trade-off, and (4) synthesis. These terms are defined as follows:

Translation - determining a common language (or terminology) for the statement of problem objectives and constraints that are acceptable to, and understandable by, all participants.

Analysis - determining as many alternative approaches as possible to solve the problem as a whole or to solve portions of the problem.

Trade-Off Study - applying selection criteria and constraints to choose the approaches or tasks to be implemented.

Synthesis - a combination of the analysis and trade-off phases to achieve a "best" solution to the problem statement that was structured during the translation phase.

1. Frosch, Robert A.: A New Look at Systems Engineering. IEEE Spectrum, vol. 6, no. 9, 1969, p. 24.

THE SYSTEMS APPROACH (DEDUCTIVE/INDUCTIVE)

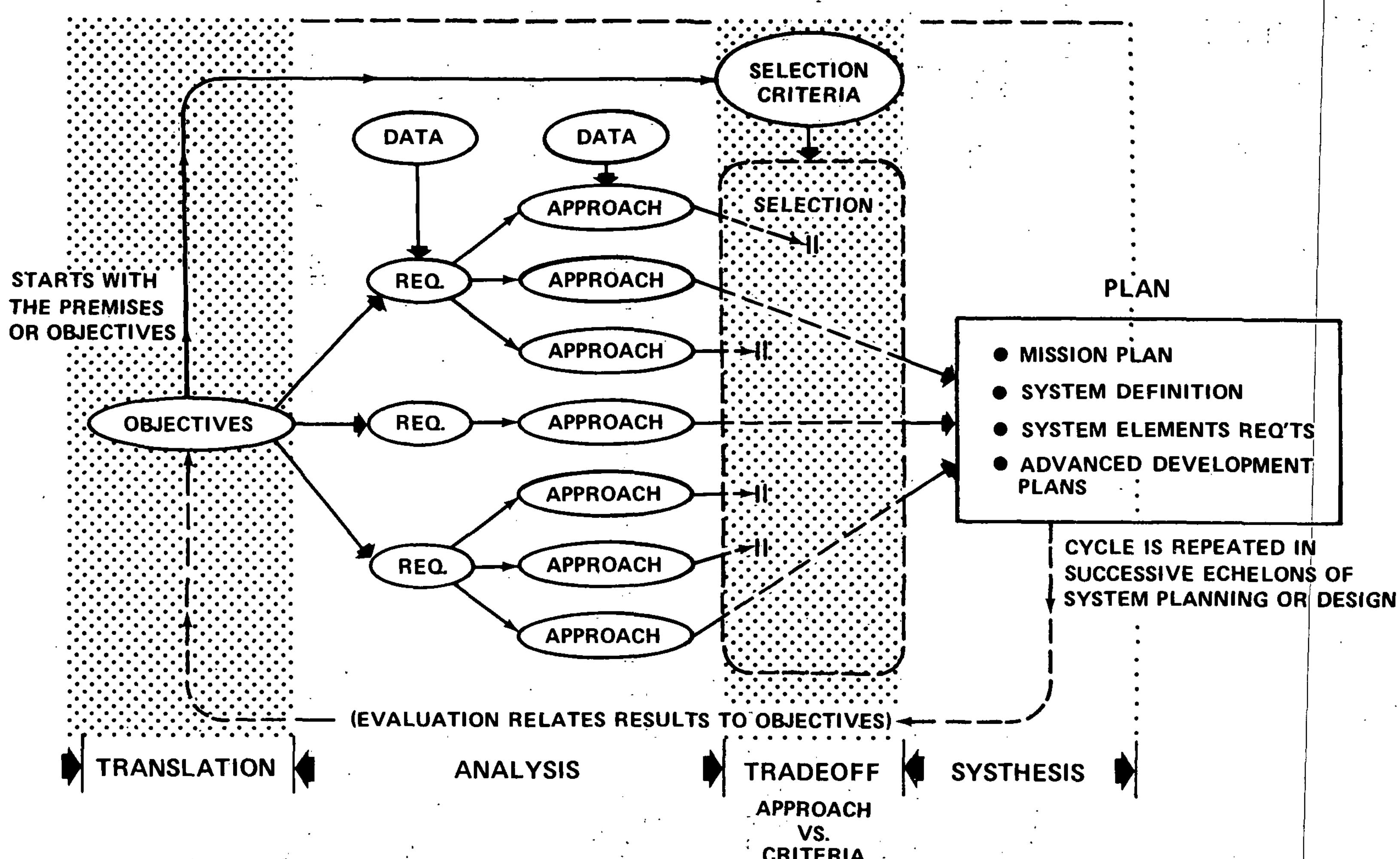


Figure 1. Steps in the systems approach.

Figure 2 shows the steps within the approach, and Figure 3 shows that a systems approach consists of a sequence of cycles. Each succeeding cycle gives more detail to the developing strategy or solution. These diagrams do not indicate the necessity for involving many disciplines, nor do they indicate the necessity for attention to the group dynamics involved in progressing to a solution, strategy, or plan, whether it is embroyonic or a final system.

1971 MSFC-Auburn Systems Approach Experience

The application of space-age technology to housing and the environment constituted the suggested work statement for the 1971 MSFC-Auburn Engineering Systems Design Summer Faculty Fellowship Program. The exact task to be accomplished by way of the training exercise for the ASEE-NASA sponsored program was not specified. It was decided by the staff of the program that a problem as large as any aspect of the housing problem should be approached in a systematic way consistent with the program intent and an objective or task should be identified using a systems approach.

The basic systems approach as employed is illustrated in Figure 1. As is seen, any problem is viewed as consisting of an objective, requirements to satisfy the objective and constraints, and criteria which are controls that must be considered when trading off approaches to the requirements to arrive at a plan or means of satisfying the objective. The steps of the systems approach used seem obvious until the problem becomes complex and one has difficulty in identifying an objective, requirements, constraints, and criteria.

It is easy to state that applying the systems approach to a complex problem is difficult but it is hard to convey the difficulties once the approach is applied and the well-ordered steps are set out to show what was done. The reader of this document must realize that application of the systems approach to housing is not easy but the lucid presentation of the housing problem as a result of applying the process is worth the effort involved. First, the housing problem, if one thinks in terms of the total housing concept, considers how man lives in his environment and is multidisciplinary in nature with ill-defined interrelationships of disciplines. The material presented establishes how the MSFC-Auburn faculty fellows attacked a problem area foreign to the majority of the group. The chronology of events should prove useful to anyone uninitiated to the problem area who thinks of applying the systems approach or systems engineering to housing. The group effort represents about 2 man-years of work considering the first half of the problem is an

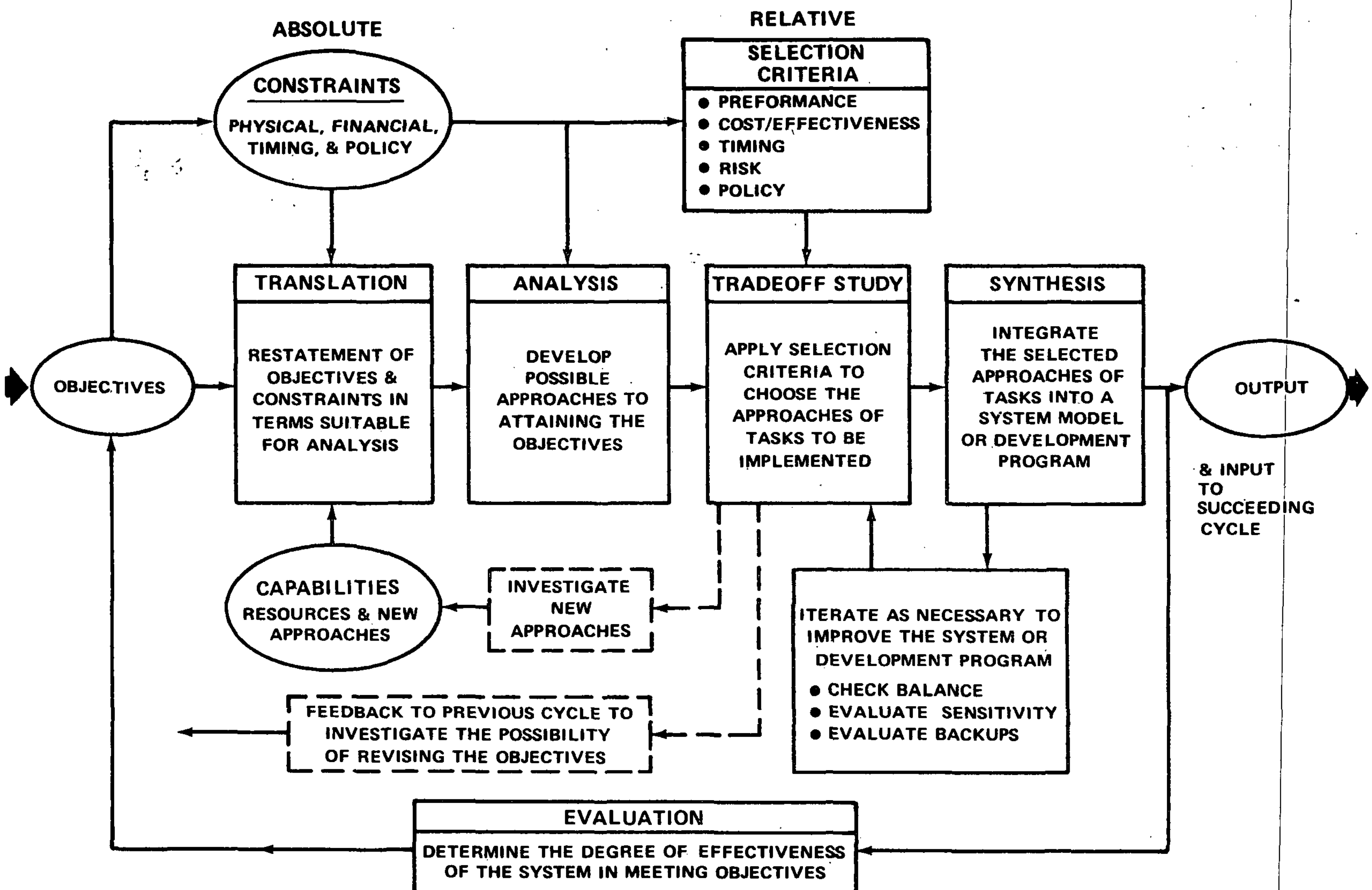


Figure 2. Steps within the systems approach.

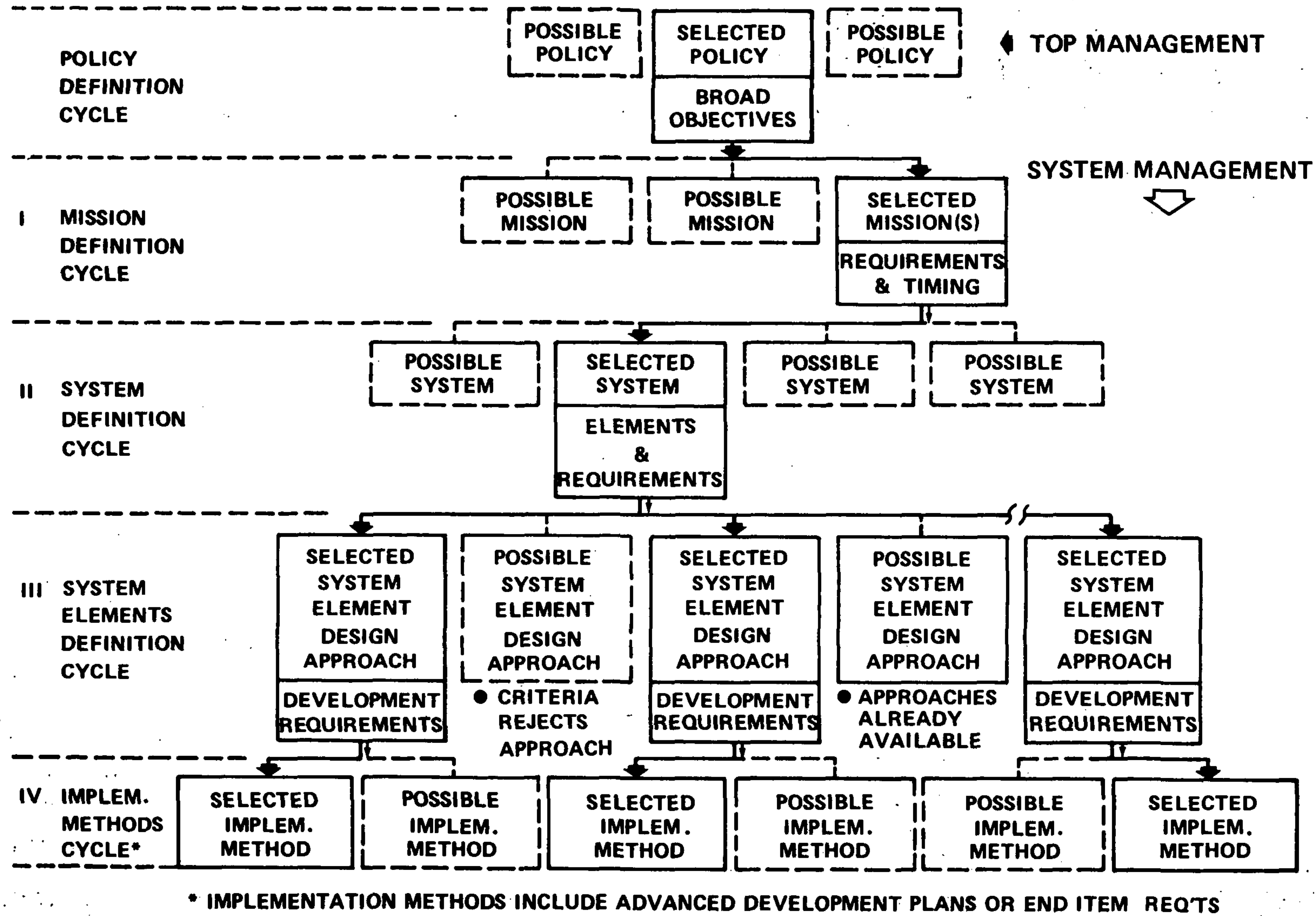


Figure 3. The concept of sequence of cycles.

information-gathering process. The following discussion traces the events of the group and sets the stage for the reader.

On Friday of the first week at MSFC, the fellows commenced to consider the problem as described in the first paragraph. The following Monday, the fellows decided that before an objective could be well defined, they would need information on the housing problem. Since information on the housing problem is in itself an objective, the systems approach is applicable to solve this problem as indicated in Figure 4. The requirements for this objective are information acquisition areas as identified by the generic topic areas established by the fellows. Figure 5 shows the task groups that the fellows decided upon. The task-group titles parallel the information acquisition areas. The fellows elected task-group leaders and project leaders three times during the course of the program as shown. Also, it should be pointed out that the fellows volunteered membership for a particular task group. Each of these information acquisition groups had a number of approaches as to ways to gather data. These approaches are identified and include speakers, libraries, inquiries, etc. The trade-off of information acquisition approaches was controlled by the constraints and criteria identified in Figure 4. The speakers were preselected by the staff since the participants would not have had time to arrange for the number of speakers needed to gather information germane to the problem. The resulting body of information summarized later in the report at the end of 5 weeks identified a number of objectives as each speaker presented a topic of interest to him. Some of these objectives are:

Early Fire and Smoke Detection
Disposal-Solid Waste
Power Line Fault Detection
Coupling of Connectors of Hoses
Fireman Life Support Systems
Systems Approach Management Technique
Soil Testing
Control-Command Systems
Water Systems
Construction
Relocation
Urban Technicians
Housing Abandonment
Housing Objective
Reducing Decision Areas
Cooperation of Labor Unions

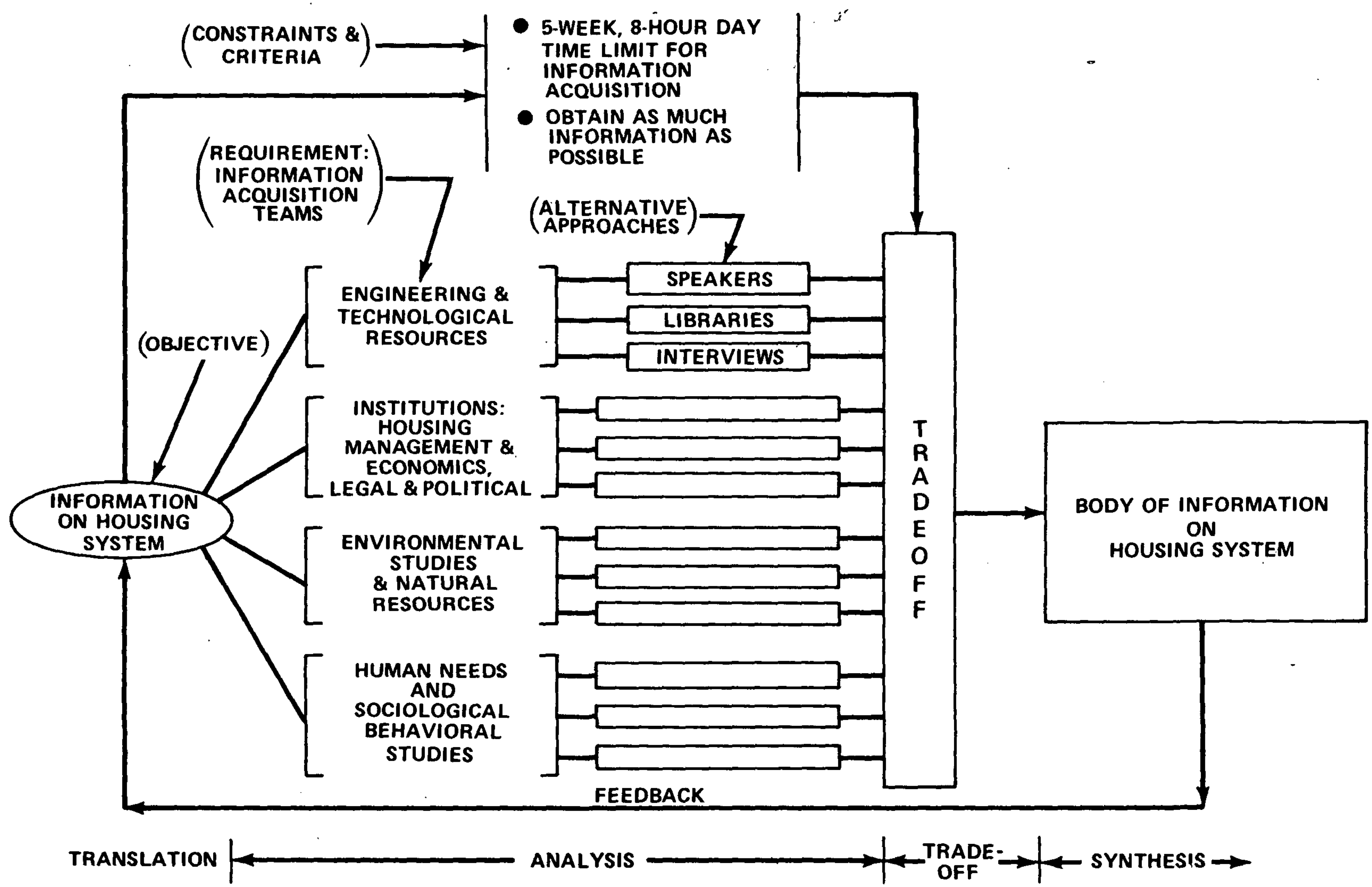


Figure 4. Participant organization at the beginning of the second week to enter information on housing system to select objective.

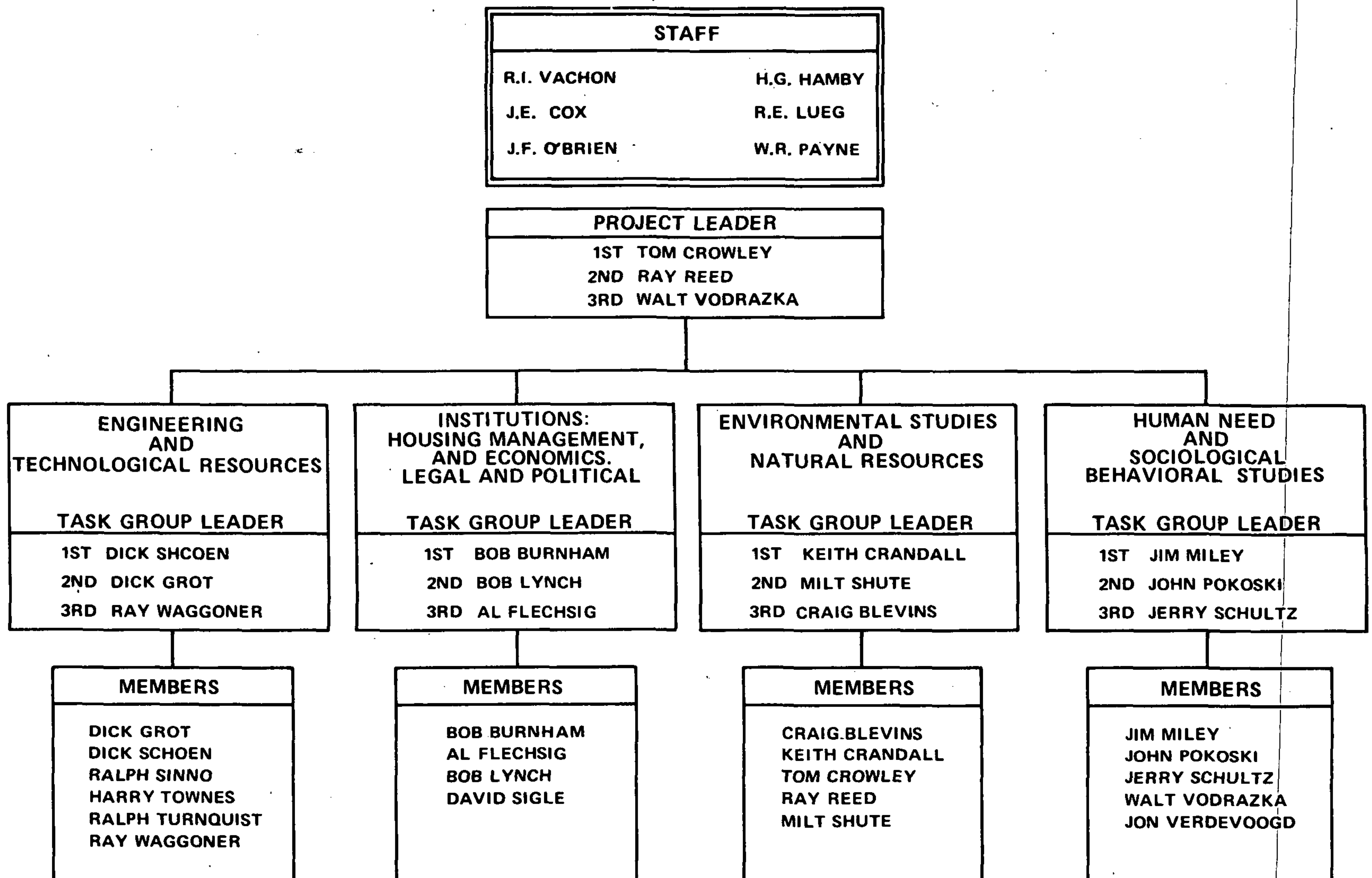


Figure 5. Organizational chart of Auburn design program.

Application of Plastic Adhesives
Greater Adaptation of Flat Cable Technology
Adaptation of Heat Shield Benefits
Testing Fire Deterrents
Bathroom Bar Safety
Less Toxic Fire Retardant Material
National Building Research Institute
Definition of Housing Market
Reduction of Corrosion
User-Needs Model
Safer Stairways
Government Cooperation (Local-Regional)
Reduction of Electrical Shock

Using the systems approach diagram, the next step of the participants is shown in Figure 6. Here, the objective was to select an objective and the requirement was information on objectives which had been gathered previously. Thus, there were several objectives that were available for trade-off. The constraints and criteria, controlling factors (Fig. 6) for trade-off dictated to the participants the program objective — mechanism for decisionmaking and policy development for housing. By having this objective developed during the seventh week, the group then established the requirements for this objective as shown in Figure 7. Figure 7 shows that the basic requirements for such an objective are a model or models of the housing problem and an organization for studying, using, and developing the model and presenting results of the model output subsequent to known inputs. As is seen in Figure 7, each of these two requirements is in itself an objective for a systems approach study as are some of the constraints and criteria. Furthermore, as indicated, the decisionmaker that the organization may be responsible to has not been identified a priori since this is felt to be a part of the systems approach. Figure 8 shows the nesting of these two requirements, objectives in themselves, in the diagram for the systems approach for the main objective. Chapter III discusses the problem as a continuum of Figures 7 and 8, and Chapter VIII discusses the development of a model.

The report discusses the results of the effort and it is felt that the report presents the housing situation as a total picture. The reader working in a particular area of housing should consider this report a companion document to his own background and experience and use the report to view interactions of other interests with his own.

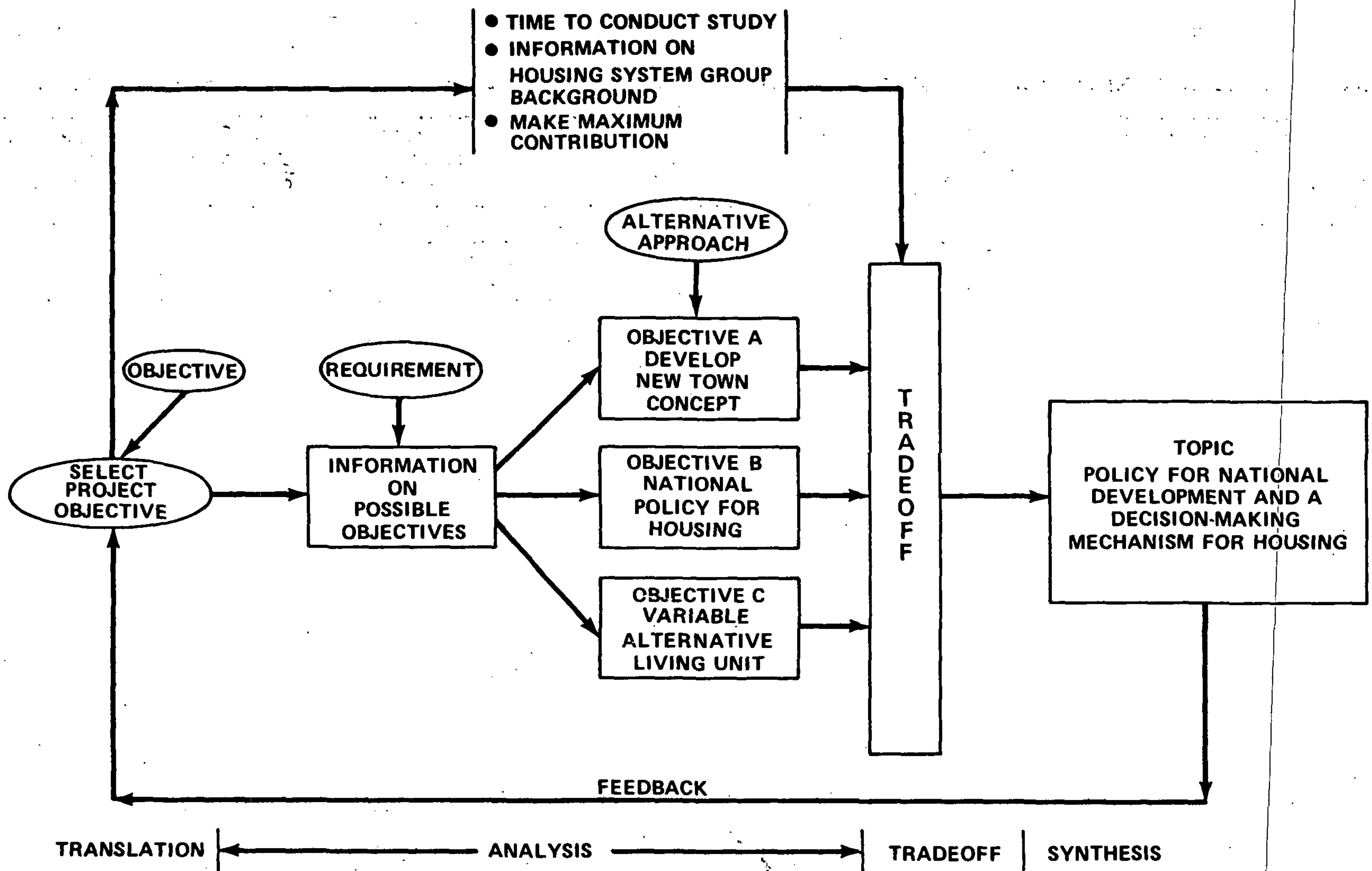


Figure 6. Participant interaction at the beginning of the seventh week to select topic for study and apply NASA System's Design Technology.

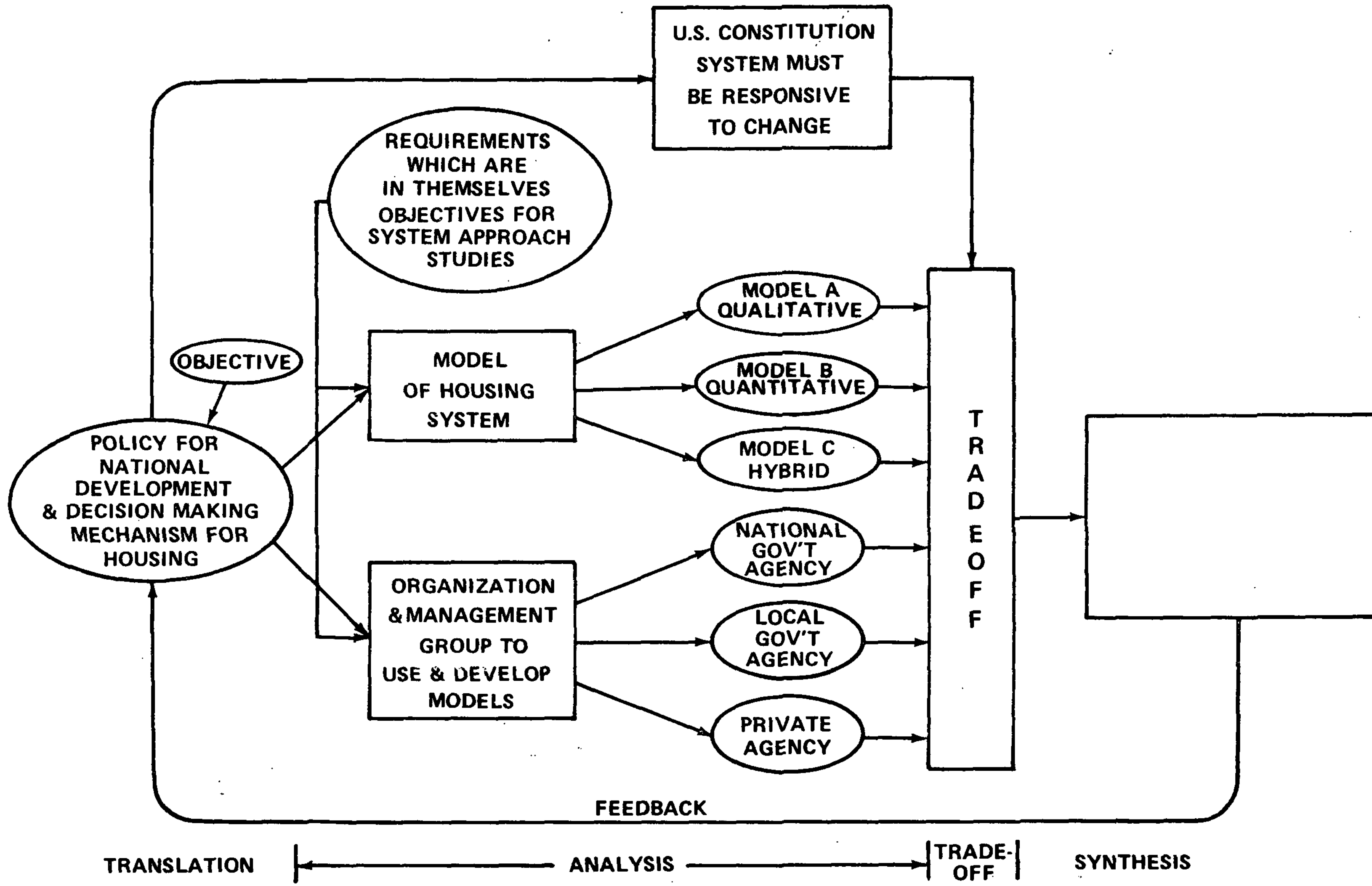


Figure 7. Diagram of systems approach to objective selected for study (note nesting of systems approach objectives as shown in Fig. 5).

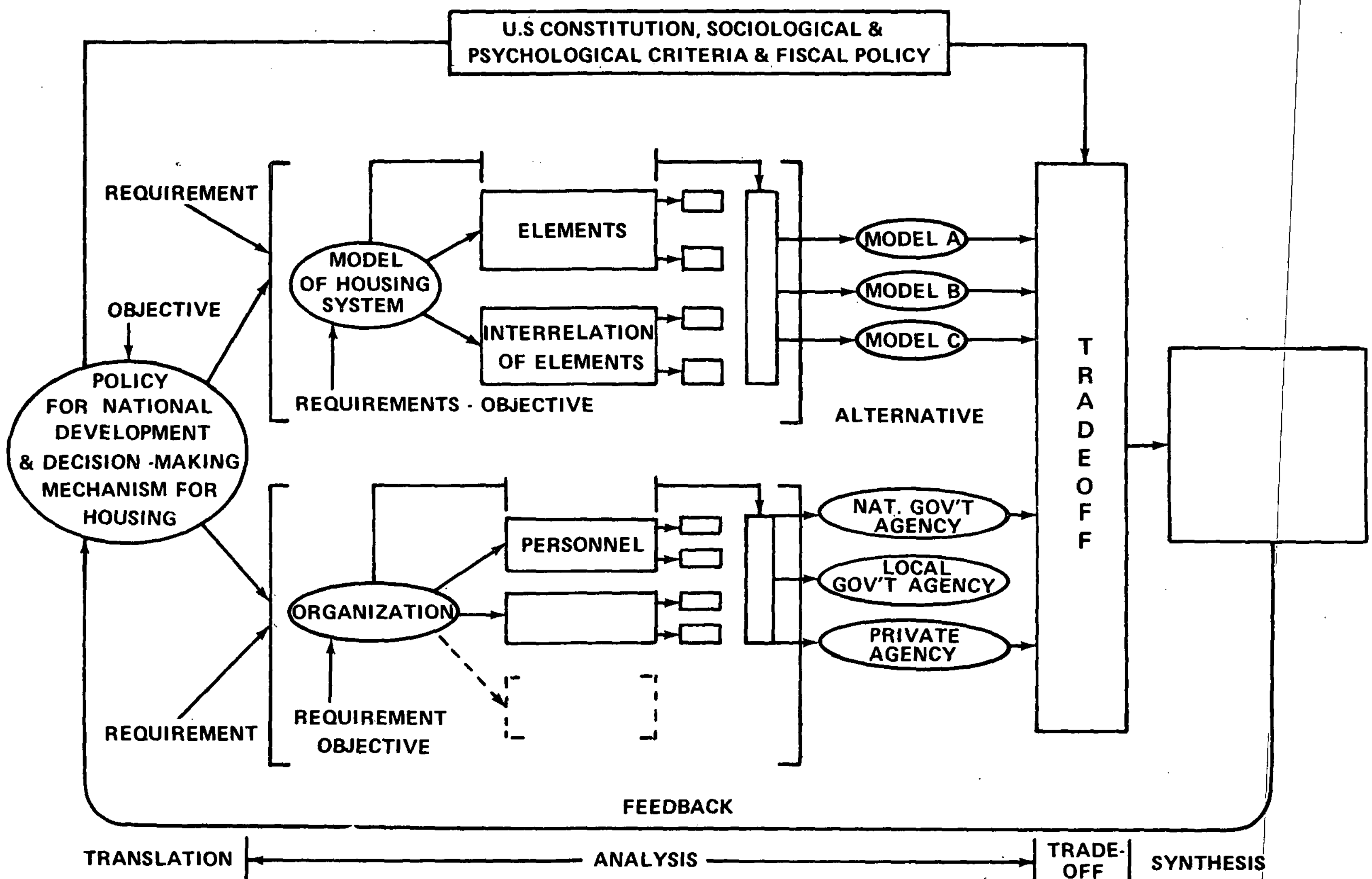


Figure 8. Diagram of systems approach to objective selected for study showing requirements of primary study as objective approach studies nested in the primary study.

Group Dynamics

Group dynamics consisted of three phases. The first 6 weeks were devoted almost exclusively to data acquisition. The second phase, starting at the beginning of the seventh week, can be characterized as a period of beginning awareness of the systems approach. Although the natural logic of the systems approach had been used during the first and second phases as diagrammed in Figures 4 and 6, the participants were not diagramming their activities and relating them to the basic systems approach of Figure 1. A discussion of progress on Monday of the eighth week, using diagrams such as shown in Figures 4 and 6, established the beginning of this awareness of the definition of a systems approach. It is difficult to live a systems approach experience although it is easy to study such an approach. The generation of an experience and the involvement of the persons generating such an experience leads to some predictable group reactions although one does not know when to expect the reaction. Some typical reactions are bruised egos resulting from presenting ideas that are attached before the ideas are firm in everyone's mind. This reaction can be disasterous except that professionals usually have a desire to contribute and push on if given encouragement. The bruised ego syndrome gave way to one of "let's get on with the business" at the conclusion of the eighth week in this study. In fact, the cooperative attitude was so pervasive that contention was absent and gave way to considerate debate with the objective of teaching and learning. The last phase was a concentration on developing a housing model and bringing the material together,

The freedom of the group to develop and explore a problem of immense proportions was stimulating and made possible by the willingness of MSFC to give the program a free reign. The only deterrent to the group was a lack of reference materials due to the size of the problem.

LIST OF PARTICIPANTS

Summer Faculty Participants

Craig M. Blevins Professor of Engineering Graphics University of Alabama	M.S. (Industrial Education and Industrial Arts) Kansas State, 1953 B. S. (Education) Kansas State, 1939
Robert C. Burnham Assistant Professor of Architecture Carnegie-Mellon University	M. (Architecture) University of California, 1970 B. (Architecture) Carnegie Institute of Technology, 1966
Keith C. Crandall Acting Associate Professor of Civil Engineering University of California	Ph.D (CE) Stanford University, 1970 M. S. (CE) University of Washington 1963 B. S. (CE) University of Washington, 1962
Thomas J. Crowley Research Associate Harvard School of Public Health	M. S. (ME) Northeastern University, 1962 B. S. (ME) Northeastern University, 1958
Alfred J. Flechsig, Jr. Assistant Professor of Electrical Engineering Washington State University	Ph.D. (EE) Louisiana State University, 1970 M. S. (EE) Washington State University, 1959 B. S (EE) Washington State University, 1957
Richard A. Grot Assistant Professor of Aerospace & Mechanical Science Princeton University	Ph.D. (ESE) Purdue University, 1966 M. S. (ESE) Purdue University, 1962 B. S. (ESE) Purdue University, 1961
Robert D. Lynch Associate Professor of Civil Engineering Villanova University	Ph.D. (CE) University of Notre Dame, 1968 M. S. (CE) University of Pennsylvania, 1960 B. S. (CE) Villanova University, 1953

LIST OF PARTICIPANTS (Continued)

James D. Miley Assistant Professor of Sociology Kansas State University	Ph.D. (Sociology) Tulane University, 1970 M. A. (Sociology) Louisiana State University, 1963 B. A. (Philosophy) Millsaps College, 1959
John L. Pokoski Assistant Professor of Electrical Engineering University of New Hampshire	Ph.D. (EE) Montana State University, 1967 M. S. E. (EE) Arizona State University, 1965 B. S. (EE) St. Louis University, 1959
Raymond D. Reed Professor of Architecture Iowa State University	M. (Architecture) Harvard University, 1958 B. (Architecture) Tulane University 1953
Richard Schoen Architect/Partner Lomax-Associates-Architects, Los Angeles, California Lecturer, School of Architecture & Urban Planning - UCLA	M. (Architecture) University of California, 1971 B. (Architecture) University of California, 1961
Jerold M. Schultz Associate Professor of Metallurgy University of Delaware	Ph.D. (Metallurgical Engineering) Carnegie-Mellon University, 1965 M. S. (Metallurgical Engineering) University of California, 1959 B. S. (Metallurgical Engineering) University of California, 1958
Milton Shute Associate Professor and Head of Agricultural Engineering Department Wisconsin State University	Ph.D. (AE) University of Missouri, 1964 M. S. (AE) Cornell University, 1952 B. S. (AE) University of Georgia, 1951
John D. Sigle Associate Professor of Architecture Southern University	M. (Architecture History) University of Virginia, 1967 B. (Architecture) Texas University, 1965

LIST OF PARTICIPANTS (Concluded)

Raouf R. Sinno Associate Professor of Civil Engineering Mississippi State University	Ph.D. (DE) Texas A&M University, 1968 M. S. (CE) Louisiana State University, 1964 B. S. (CE) University of Florida, 1962
Harry W. Townes Associate Professor of Aerospace & Mechanical Engineering Montana State University	Ph.D. (ME) California Institute of Technology, 1965 M. S. (ME) California Institute of Technology, 1960 Sc.B. (Engineering) Brown University, 1959
Ralph O. Turnquist Associate Professor of Mechanical Engineering Kansas State University	Ph.D. (ME) Case Institute of Technology, 1965 M. S. (ME) Kansas State University, 1961 B. S. (ME) Kansas State University, 1952
Walter C. Vodrazka Associate Professor of Civil Engineering Wisconsin State University	Ph.D. (CE) Purdue University, 1968 M. S. (CE) Mississippi State University, 1962 B.C.E. (CE) Manhattan College, 1955
Jon D. Vredevoogd Instructor of Human Environment & Design Michigan State University	M.F.A. (Interior Design) Pratt Institute, 1968 B. S. (Interior Design) Michigan State University, 1965
Raymond C. Waggoner Associate Professor of Chemical Engineering University of Missouri-Rolla	Ph.D. (CE) Texas A&M University, 1964 M. E. (CE) Texas A&M University, 1961 B. (CE) University of Louisville, 1952

STAFF

Technical

Herman G. Hamby Staff Scientist Program Development Marshall Space Flight Center	M. S. (Physics) University of Georgia, 1961 B. S. (Physics) University of Georgia, 1950
Russell E. Lueg Professor of Electrical Engineering University of Alabama	Ph.D. (EE) University of Texas, 1961 M. S. (EE) University of Texas, 1956 B. S. (EE) University of Arkansas, 1951
Reginald I. Vachon Alumni Professor of Mechanical Engineering Auburn University	L.L.B. Jones Law School, 1969 Ph.D. (ME) Oklahoma State University, 1963 M.S. (Nuclear Science) Auburn University, 1960 B. S. (ME) Auburn University, 1958

Administrative

J. Fred O'Brien, Jr. Assistant Director, Engineering Extension Auburn University	M. S. (ME) Auburn University, 1959 B. S. (ME) Auburn University, 1957

Consultant

Jim E. Cox Associate Professor of Mechanical Engineering University of Houston	Ph.D. (ME) Oklahoma State University, 1963 M. S. (ME) Southern Methodist University, 1960 B. S. (ME) Southern Methodist University, 1958

ACKNOWLEDGEMENTS

The completion of STARSITE and the training exercise in the systems approach would not have been possible without the support and cooperation of the people of the Marshall Space Flight Center and the many others listed in this section. The participants and staff have noticed that the support is enthusiastic and voluntary in many instances. Long association with the center has developed close ties with center personnel, and it is hoped the training exercise in some small way contributes to the success of MSFC. It is not possible to list everyone with whom we have worked. We have listed some of the speakers and contributors to the program on the following pages.

Our special thanks go to Dr. E.F.M. Rees, Director MSFC; Mr. Jim Murphy, Director Program Development; Dr. Ernst Stuhlinger, Associate Director for Science; Dr. George Bucher, Deputy Assistant Director of Sciences; and Mr. Marion Kent, University Affairs Office. Mr. Herman Hamby, our co-director deserves our continued appreciation for working with us this year and for the past 3 years as does Mr. Jim Downey, Acting Associate Director for Advanced Planning, and Mr. Herman Gierow, Chief of Mission Payload and Planning of Program Development. Mr. W. R. Payne of MSFC has been instrumental in our activities and as usual ensures the documentation of this report.

Mrs. J. M. Miller has worked with us for 4 years, and each year we try her good nature and somehow she still helps us in every way. The tours and arrangements through the Protocol and Transportation Branches have been very valuable. Appreciation is due Mr. E. S. Schorsten and Commander W. K. Martin.

Mr. Jim Dowdy and Mr. Clyde Hightower have supported this training effort in many ways and have ensured the success of the program.

Mr. Bart Slattery, Dr. Frank Hansing of the Public Affairs Office, and Mr. Charles Carter of the Office of University Affairs (NASA Headquarters) have supported the program for many years and have arranged funding for the program. This program is a farsighted effort and the return to the nation will come during a time of great stress and anxiety.

Finally, the secretarial assistance of some of the administrative assistants and secretaries and our own is appreciated. Mrs. Bonnie Holmes, Mrs. Molly Payne, and Mrs. Jerre Wright of MSFC and Miss Patti Keiser,

Mrs. Brenda Cash, Mrs. Jane Bass, Mrs. Donna Porter, and Mrs. Diana Tyler on our staff have been of tremendous assistance.

The following pages list the people who have worked with us in many ways. Any success this program has is a result of the friends mentioned above and on the following pages.

GUEST SPEAKERS AND OTHER CONTRIBUTORS

Speakers

LEGISLATIVE BRANCH

The Honorable John Sparkman
U. S. Senator (Alabama)

MARSHALL SPACE FLIGHT CENTER

Dr. Eberhard F.M. Rees
Director

Mr. Samuel E. McCrary
Technology Utilization

Mr. James B. Bramlett
Program Development

Mr. John A. Stucker
Administration and Technical Services

Mr. John C. Goodrum
Program Development

Mr. Wilhelm Angele
Science and Engineering

Mr. James Hankins
Science and Engineering

Mr. Ralph Herndon
Science and Engineering

Mr. Gordon Parks
Science and Engineering

Mr. George Butler, Jr.
Science and Engineering

Mr. Dieter Grau
Science and Engineering

NASA HEADQUARTERS

Mr. Roy G. Bivins, Jr.

INDUSTRY

Mr. James Simpson
Consultant

Mr. Richard Foster
ABT Associates

Mr. E. J. Campbell
Missouri Continental Homes

Mr. Robert Cooper
Missouri Continental Homes

Mr. Dillard Powell
Missouri Continental Homes

Mr. Walter Wiesman
Consultant

Mr. Richard W. Lisska
Aluminum Company of America

Col. Samuel H. Lowry
Teledyne Brown Engineering

Mr. Roy Barron
Alabama Power Company

Mr. H. J. Young
Edison Electric Institute

Dr. Otto Klima
General Electric Company

OTHER GOVERNMENT AGENCIES

Mr. David Pellish
New York State
Urban Development Corporation

Dr. Julian Kobler
Redstone Scientific Information Center

Mr. Woodrow B. Peek
Top of Alabama Regional Housing Authority

Mr. Dean Y. Matthews
Top of Alabama Regional Council of Governments

Mr. Jerome I. Weinstein
Camden Housing Improvement Projects

Mr. Tom Armstrong
Department of Housing and Urban Development - Atlanta, Georgia

Dr. Mathew Radnofsky
Manned Spacecraft Center

Mr. Charles T. Muntain
Department of Housing and Urban Development - Washington, D.C.

Mr. Charles A. Wilson
Ames Research Center

Mr. Ralph Warburton
Department of Housing and Urban Development - Washington, D. C.

Mr. William R. New
Tennessee Valley Authority

Mr. Harold Falkenberry
Tennessee Valley Authority

Mr. Charles T. Mahaffey
National Bureau of Standards

INSTITUTES, ACADEMIES, AND WORKSHOPS

Mr. Don Conway
American Institute of Architects

Mr. Julius Stulman
World Institute

Mr. Robert Dillon
National Academy of Sciences

Mr. Issac Adams
Watts Urban Workshop

Mr. Eugene Brooks
Watts Urban Workshop

UNIVERSITIES

Professor Herman G. Berkman
New York University

Professor Joseph Intermaggio
Virginia Polytechnic Institute

Professor Richard Wyskida
University of Alabama, Huntsville

Other Contributors

LEGISLATIVE BRANCH

The Honorable Gaylord Nelson
U. S. Senator (Wisconsin)

Mr. Steven P. Quarles
Special Counsel, Committee on Interior and Insular Affairs (Senator Jackson's Committee)

Mr. Robert Rizzi
Special Assistant (Senator Proxmire)

Office of the Honorable Thomas McIntire
U. S. Senator (New Hampshire)

ASEE

Mr. Timothy X. Bradley

Mr. Larry Sigler

OTHER GOVERNMENT AGENCIES

Dr. Philip Friedly
Department of Housing and Urban Development

Mr. Campbell Gibson
U. S. Census Bureau

Mr. Robert Grymes
U. S. Census Bureau

Mr. Robert King
Department of Transportation

Dr. Martin J Redding
Department of Transportation

Mr. James N. Smith
Conservation Foundation

Mr. Judith Kopff
Department of Housing and Urban Development

Mr. David A. Hamil
Department of Agriculture

Mr. David Askegaard
Department of Agriculture

MANNED SPACECRAFT CENTER

Mrs. Barbara Eande

KENNEDY SPACE CENTER

Mrs. Mae Stover

NASA HEADQUARTERS

Mr. Jurgen Pohly

Mr. Merle Waugh

MARSHALL SPACE FLIGHT CENTER

Mr. J. D. Bennight

Mrs. Jane Bentley

Mr. E. L. Brown

Dr. George Bucher

Mr. S. D. Ellis

Mr. Marion Kent

Mr. Erich McInnis

Mr. Paul Schuerer

Mr. William G. Simpson

Mr. Mack W. Shettles

Mr. William L. Brien

Mr. James F Dowdy

Mr. Clyde M. Hightower

Mr. Ernst Stuhlinger

INDUSTRY

Mr. Dave MacFadyen
ABT Associates

Mr. George Merriweather
Friendswood Development Company

Mr. Robert Garrett
Friendswood Development Company

Mr. Herbert C. Smith
Westinghouse Electric Corporation

Mr. Norman L. Rutgers
Lennox Industries, Inc.

Mr. Samuel Strickland
Boeing Computer Services

Mr. William Caudill
Caudill Rowlett and Scott

COLLEGES

Dr. Gene Ermert
Athens College

LIST OF ACRONYMS

FNMA	"Fannie Mae" Federal National Mortgage Association buys and sells FHA-insured and Veterans Administration-guaranteed loans to improve distribution of home mortgage funds. Its special assistance purchases support FHA Sections 220 and 221 programs that are designed to help urban renewal redevelopment, rehabilitations, and relocation activities. The Housing and Urban Development Act of 1968 divided FNMA into two separate corporations, one to manage the special assistance functions and the other to administer the secondary market operations. Until 1968, all of FNMA was part of the Department of Housing and Urban Development. The new FNMA is a "Government-Sponsored Private Corporation." It now primarily deals in secondary market operations.
GNMA	"Ginnie Mae" Government National Mortgage Association was established by the Housing and Urban Development Act of 1968 as a corporation remaining within the Department of Housing and Urban Development which would retain the special assistance, management, and liquidating functions formerly performed by FNMA. It is charged with the task of substituting private financing for treasury borrowings required to carry mortgages relative to its management and liquidating functions. The secretary of HUD appoints the officers of the corporation. He determines the general policies which govern the operations.
HEW	Department of Health, Education, and Welfare.
HUD	Department of Housing and Urban Development.
NBS	National Bureau of Standards.
NCSBCS	National Conference of States on Building Codes and Standards.
SMSA	Standard Metropolitan Statistical Area.
UNISTAR	User Network for Information Storage, Transfer, Acquisition, and Retrieval.

FOREWORD

The systems approach exercise began by exposing the participants to a common body of information through seminars on the board as well as the particular aspects of the housing and environmental problems confronting our nation. For 5 weeks, the 20 faculty participants listened to speakers, read literature, and visited various facilities at the Marshall Space Flight Center in an effort to collect much information in a minimum amount of time.

Abstracts of Speakers' Remarks

Seminar speakers were recruited from local, regional, and national industrial and government organizations. A very brief resume of the speakers' remarks follows. For a more detailed report on the speakers' comments, see Appendix A.

Mr. Roy Bivins, Project Manager of a Technology Utilization Team, NASA Headquarters, Washington, D. C., stated that NASA is very interested in seeing that the spinoff technology of the aerospace industry is applied to today's problems.

Mr. James Simpson, Private Consultant and former Director of Technology for the Department of Housing and Urban Development, gave an excellent broad pragmatic overview of the housing challenges and opportunities that face the country. He indicated that there is little motivation to lower the costs of construction since the architect, builder, and banker often received their return as a function of the cost. The lowering of cost and fire prevention are the two major problems facing the housing industry. Everyone wants to have a voice as to the type of home in which they wish to live; therefore, any complex of housing should offer several alternatives of living styles as people want to determine their own tradeoffs between quality and cost. Individual or family privacy and isolation from noise are very important considerations. A few of the barriers to progress in the housing area includes skepticism of lenders about new untried innovations, refusal of insurors to underwrite new innovations, building code requirements that stifle new innovations, hesitancy of labor unions to adopt the new innovations, and even stringent government regulations that discourage the introduction of new innovations.

Mr. Richard Foster, ABT Associate, Cambridge, Massachusetts, discussed NASA technology as applied to housing. He indicated that it is

difficult for technology developed for one context such as the aerospace industry to be transferred for use in another context such as solving social or housing problems. Smoke detectors, intumescent paints, foam-asbestos, plastic foams, chemically-treated cardboard, low voltage wiring, disposal of solid wastes, and soil testing are examples of specific applications of NASA technology that could be applied to the housing industry.

Mr. David Pellish, Director of Building Research and Technology, New York State Urban Development Corporation, discussed problems in the urban areas of New York and the application of technology to these problems by the Urban Development Corporation. He believes that housing is a most urgent problem and presents a difficult challenge to meet because housing money is scarce, resources available are short, and they are used in an inefficient manner. Technologists should be utilized to the utmost in the construction industry. We should look at the way we use technology and the reasons why we did certain things in the past and how they affect our present outlook. Although innovations are difficult to introduce, the technologist should be encouraged to make contributions in such areas as lengthening the life of mechanical equipment (which now lasts fewer years than the house), simplify house wiring systems, reevaluate house design to reduce labor costs, improve the fire safety for the home, and reduce the amount of water needed to serve a home.

Mr. Don Conway, Director of Research Programs, The American Institute of Architects, stressed the importance of considering housing as a user rather than a technically-oriented problem. Almost all buildings should be defined as behavior settings for human activities and feedback systems between the ultimate user and the home designer need to be established.

Professor Herman G. Berkman, Professor of Planning, New York University, concluded the first week's seminars with a lecture on the economics of housing. He indicated that even if the cost of the physical housing unit is reduced, the cost of land on which housing is located can be expected to rise concomittantly since most of the profit in housing is made in the financing of homes and land speculation. Cycles in the building industry typically go contrary to the rest of the economy and are more severe in amplitude. The single most important factor that affects housing are the conditions on which credit is made available.

Mr. Samuel McCrary, Aerospace Engineer with Technology Utilization, Marshall Space Flight Center, gave a useful talk on "The Systems Approach,

A Century of Perspective." For the systems approach to be effective, an adequate technological background and a proper attitude among the workers are important.

Mr. Woodrow B. Peek, Program Coordinator, Top of Alabama Regional Housing Authority, Huntsville, gave an informative overview of how HUD programs are funded and administered at the local level. He anticipates a future great increase in the volume of usage of modular construction and indicated that a foam sandwich panel house is presently being constructed in Huntsville under the sponsorship of the Navy.

Mr. Dean Mathews, Executive Director of the Top of Alabama Regional Council of Governments, complemented the address of Mr. Peek by showing how TARCOG as well as TARHA seek to provide suitable housing for the low income groups. He feels that there are too many organizations involved in broad housing decisions, and, because of this, much red tape is encountered.

Mr. James Bramlett, who is involved in space station studies at the Marshall Space Flight Center, showed how the space station module was developed. Some of the techniques employed by NASA in the development of the space station can be applied to the housing industry on earth.

Mr. E. G. Campbell, Mid-West Divisional Sales Manager, Mr. Robert Cooper, President, and Mr. Dillard Powell, Vice President for Engineering of Missouri Continental Homes, cited many of the problems and promises of the modular housing industry in this country. Continental Homes deals with the construction and guarantee of the dwelling but does not enter into land acquisition or other ancillary activities. Several benefits which seem to result from their operation include guaranteed cost control, controlled delivery, savings in regard to the trades and labor unions, quick turnover yields, savings on building financing, quality materials, precision engineering, and architect-approved design. They usually can promise to set up a house within 72 hours; they build to meet over 350 different codes and specifications and have indicated that if a uniform code were adopted, approximately 10 percent could be saved on the cost of each home. Transportation is a major factor in reducing costs because it is usually uneconomical to transport a home more than 250 miles from the factory.

Following Mr. Campbell, Mr. Cooper indicated that modular housing is the most modern concept in housing fabrication today and that Continental produces houses with up to 2000 ft^2 of floor space. Although mobile homes

are more profitable, they usually do not meet the code requirements for a fixed home. The industry is tough and competitive and good management practices are essential. The modular builder is very much consumer-conscious since units must be built that appeal to the buyer. Low income people as well as those in the upper income bracket want houses that have visual appeal and are functional.

Mr. Dillard Powell showed how a modular home is constructed in the factory using wood framing and gypsum board. Plumbing and electrical fixtures are installed and the house is roof painted and prepared for shipment on special trucks and beds that were designed to load, deliver, and unload houses at the building site. This specialized equipment is considered a very important part of their overall operation.

Dr. Joseph Intermaggio, Professor of Planning, Virginia Polytechnic Institute, told the group about the Reston and Columbia projects as well as the proposed new town within a town in Birmingham, Alabama. He believes that the wealth of this country is in the cities but the city is on the verge of a severe national crisis in productivity and resources and is not satisfying the needs of society. He offered a few suggestions for choosing the developers of a new city. They should possess sufficient talents to build a city to be assured of adequate capital to realize the dream and should avoid conflicts with established governmental units. Some of the limitations in building communities are high interest rates, current land costs, developers who lack risk capital, and expensive special studies that are necessary before construction can begin.

Mr. Jerome I. Weinstein, Director of the Camden Housing Improvement Project, completed the second week of seminars with a seminar on housing rehibilitation. He indicated that even though rehibilitation of old homes or dwellings may be even more uneconomical than the construction of new industrialized housing, the rehabilitation program may be a social success as other homeowners have been encouraged to improve their own property when they see other improvements being made elsewhere. Technology is not the major problem that faces urban planners. The problems are those involving people; such as, the modes of society, codes, building inspectors, and trained personnel. They have remodeled over 300 houses but only buy empty houses as they become available on the market. He suggested that our group consider in-fill modular construction to reduce the time delay and cost of the usual rehabilitation methods.

Mr. Tom Armstrong, Assistant Regional Administrator for Metro Planning and Development, HUD, Atlanta, Georgia, stated that HUD is

being reorganized so as to make the organization more responsive to the needs of the people. Under the reorganization plans, the power to spend money will be transferred from Washington to the regional level and that perhaps the biggest problem with this plan lies in the ability to implement it because of the lack of trained personnel in urban planning and property appraisal. The Model Cities Program, in general, is a failure especially if viewed in terms of construction. One big difficulty has been in the identification of the problem by the local groups. Often, land acquisition programs are a failure because local communities tend to finance land acquisitions as well as the facility on the same local bond issue and the public rejects the program because of its total expense. Operation break-through does not possess great possibilities for technological innovations of major significance but should have great impact in making people aware that codes have added great cost to housing construction. For most urban services, technology has not had any significant impact for many years; e.g., the sewer system.

Mr. Julius Stulman, President of the World Institute, suggested that a giant brain be organized to evaluate continuously the latest technology, resources, and design so that sophisticated factory-built intermodular units, complete with utilities and appliances, are directly available to the consumer from a central depot. The key to the success of the proposed solution is a development of computer-controlled containerized handling systems. Each container, after inspection at the end of the production line, is registered, bonded, inventoried, insured, and, therefore, is a bankable product. He suggests that NASA become the creative force behind the development of the brain.

Dr. Mathew Radnofsky of MSC, Houston, gave a lecture demonstration on fire-proof materials. His philosophy is based on preventing fires rather than extinguishing them after they have started; thus, his main effort is to eliminate the fuel for possible fires by developing fireproof materials. He discussed the relative merits of such fireproof materials as beta glass, carma, pbi, durette, flourel, lightoflex, fireproof paper, polymide materials, and pyrell. He mentioned a program in which small houses which were about 5 ft on each side and constructed of conventional and fireproof materials were being tested by burning them with calibrated molotov cocktails and observing the effects. He cited that NASA has had many inquiries concerning innovations in fireproof materials and that, although there have been some adoptions, much more can be done in this area. NASA is using demonstrations in firefighting as a medium of dissemination of information.

Mr. Charles T. Muntain, Assistant to the Secretary for Labor Relations, HUD, Washington, acts as advisor to both labor unions and manufacturers in accordance with HUD policies. He made several interesting comments: (1) Industrialized housing will give the labor unions an opportunity to have control over a greater percentage of the housing starts (75 percent of present housing starts are non-union), (2) unions are reluctant to change building codes because their members are on committees that made the codes, (3) unions are presently working with the trades to establish special rates for residential work, and (4) work done in factories requires less skill than work done on the site. He stated that a national housing code is supported by HUD and that operation breakthrough is helping to change many of the present codes.

Dr. Eberhard F.M. Rees, Director of the Marshall Space Flight Center, engaged the group in an informal discussion. He feels that the growth of Huntsville presents an interesting case study for consideration as to how a city grows, and he feels that Huntsville is an ideal-sized city. He feels that the NASA-developed management techniques would be useful for urban planning.

Dr. Richard Wyskida, Professor of Planning, University of Alabama, Huntsville, and Mr. Jack Stucker, who is involved in planning at the Marshall Space Flight Center, gave some of their thoughts in regard to the economic considerations involved in planning. They stated that estimating should be done on the basis of man-hours and not dollars as adjustments for inflation and other factors are necessary if the estimate is dollar-based. They used the development of cost estimating methodology for MSFC as a case study.

Mr. Charles A. Wilson, Advisor to the Director of NASA/Ames, gave a talk that complemented that of Dr. Radnofsky as he was concerned about the results of fires that might occur in a dwelling. He stated that no test method has been designed to date for specifically measuring or quantifying factors relative to smoke and hazard factors. Such test methods are vital because of growth in exotic materials and high-rise buildings. The detection of fire is very important and must provide ample time to give warning so that the inhabitants can reach safety or a safe haven within the building itself. In large buildings, escape is usually not feasible and havens must be included in their design. Technology at its present level can solve many of the problems if we are prepared to pay the price. He cited one example in which intumescent paints are used to coat plastic bathroom fixtures so the plumbers can install them without it being a fire hazard.

Mr. Robert Dillon, Excutive Director, Building Research Advisory Board for the National Academy of Sciences in Washington, gave an interesting overview of why most industrial housing programs have failed. He cited that a significantly profitable market volume had not been generated and that a failure to develop a systematic integrated approach to housing is needed. He feels that a national building code is not advisable nor feasible because it would tend to be even more conservative than present ones. He listed several problems in providing housing such as an unstable money market, lack of a flexible labor supply, an unsteady housing market, high cost of new innovations for housing builders, difficulties in projecting future housing needs and determining the present housing stock, errors in the census information, and other problems.

Mr. John C. Goodrum, Director, Advanced Program Support Office, Program Development, Marshall Space Flight Center, discussed the application of logistics principles to housing problems and indicated that although logistics is not considered a glamorous part of systems management, it is essential as there are great potentials for cost saving and increased efficiency through proper use of logistics. He mentioned support analysis, maintainability, supply support, and transportation as important items to consider. Spare parts should be available on the market for the expected lifetime of the product and there should be a contract for performance warranty. The product should be packaged and handled so as to ensure safe arrival at its destination. Perhaps the most important point is to consider the logistics support as an integral part of the overall systems design since this results in cheaper costs and better overall systems performance.

Mr. Walter Wiesman, Consultant, stressed that the systems approach can be used to solve housing and social problems but not in the same manner as the systems approach was used in the Apollo Program. The community power structure must be known and identified before the planners attempt to develop a plan for community action such as that involving housing. The planner should look to the church leader, land owners, key businessmen, service clubs, civic organizations, etc., and sell them initially on the ideas. To implement a plan, one must find the centers of influence and the secret of the successful implementation of the systems approach is to include a personalized application.

Mr. Richard W. Lisska, Aluminum Company of America, Atlanta, Georgia, told how ALCOA is involved in using aluminum framing and rigid walls in the construction of single-family homes and garden-type apartments in conjunction with three sites involving the operation breakthrough program.

The four L's of the building industry at present are land, loans, labor, and lumber. Materials other than lumber, such as aluminum, are proving to be more economical. The main reason for builder resistance in using aluminum is based on the fact that it does not coincide with the dimensions of wood. The modular housing industry uses only a limited amount because aluminum would require extensive investment in new machinery to be utilized effectively.

Mr. Ralph Warburton, Special Assistant for Urban Design in the Department of Housing Urban Development, Washington, D. C., felt that an interdisciplinary systems approach is applicable to the solution of almost all problems including that of housing and environment. It is important that planners understand human needs when developing new innovations to minimize the user-needs problems. For instance, European housing design is not necessarily compatible with the United States' user-needs because American desires, perspectives, and value systems differ from the European counterpart. Although much has been done in researching the living habits of specific groups, not much has been done about researching the needs of the average American.

Colonel Samuel H. Lowry of Teledyne-Brown Engineering, Huntsville, has worked with the Department of Housing and Urban Development to study safety factors in the home. His study basically agreed with data published by the National Safety Council in that the predominant accident types for (1) stairs, (2) tubs and showers, (3) glass doors, (4) windows, and (5) other doors. The purpose of this study was to (1) establish the nature frequency and severity of home accidents, (2) identify the cause of factors contributing to the fixture-related home accidents, (3) relate the cause of factors to building codes and standards, and (4) develop revised or new building codes and specifications in those areas where deficiencies are apparent.

Dr. Dieter Grau and Mr. George Butler of the Quality and Reliability Division at Marshall Space Flight Center gave a seminar on Quality and Reliability Assurance Fundamentals. They gave a detailed description of the quality and reliability assurance program that was developed for the space shuttle program. Many of these techniques could be applied in the housing industry.

Mr. Roy Barron, General Sales Manager for the Alabama Power Company, Birmingham, Mr. H. J. Young, Vice President and Secretary of the Edison Electric Institute, New York, Mr. Harold L. Falkenberry, Chief of Power, Research, and Development Branch and Mr. William R. New,

Chief of Market Analysis Branch of the Tennessee Valley Authority, Chattanooga, participated in an electric utility seminar that was very interesting and informative. These gentlemen feel that the electric utility industry can meet and indeed should make every effort to meet all of the demands made for electrical energy. They are not in favor of compulsory regulation or restriction on the use of electrical energy. Although there is a profit motive in this philosophy, there is also a strong indication that the electric utility industry feels morally obligated to meet the challenge of an increasing energy demand. Of course, there was no objection to the individual consumer regulating his own consumption of energy as he desires.

There seemed to be consensus on several points of interest. The use of atomic energy (the fission process utilizing the fast breeder reactor) is expected to supply over 65 percent of our total energy needs within 30 years. Our power consumption as projected is doubled each decade over this 30-year period. Electrical energy should be able to provide all of the needs of our country as now anticipated. The use of electrically-powered transportation systems, the rapid increase in all electric homes and businesses or office structures, and a general increase in the use of electricity by all segments of society are included in the future projection. To meet the needs and desires of everyone for a better life, it is imperative that the unit cost of electricity be reduced rather than increased. With this policy in mind, false-rate structures should not be established to discourage the use of electricity because such pricing policy would discourage the use of electricity by the lower income groups in this proportionate comparison to the higher income groups, thus penalizing those groups that need the comforts and convenience that electricity can bring.

Full use of the energy generated by a power plant should be encouraged; specifically, the hot water water generated should be used usefully (such as piping the water throughout the city for heating and cooling purposes). This must be incorporated as a feature in new plant design and in conjunction with new city development for hot water usage to be economically feasible. In addition to the generation of sizable quantities of electrical energy by hydroelectric power, nuclear power, and fossil fuels, there is a revival of interest in using solar energy and geothermal means for generating electrical energy.

The five major markets for electrical energy are in lighting, stationary motors, heating, transportation, and the electrochemical industry. In the future, electric automobiles should be in more wide-spread use for nearby and intermediate distances and some form of automated highways for longer range travel.

Forecasting in the power industry has proven to be remarkably accurate. The forecast made in 1949 reaching to year 2000 is currently off by a factor of only 0.6 percent. In 1970, the per capita use of power was 5000 kW-hr/yr. This is projected to increase to 23 000 kW-hr/yr by the year 2000.

The seminar speakers presented a very optimistic picture that the electrical utility industry will be able to meet the energy needs of this country in the coming years and at the same time will be able to minimize damage to the ecological systems.

Mr. Charles T. Mahaffey of the Codes and Standards Division of the National Bureau of Standards pointed out many of the problems encountered in establishing standard tests and criteria applicable to the housing industry. Testing the new materials and structures that go into the fabrication of a house requires new, undeveloped methods. Differences in climatic regions and geographical areas are often used as a justification for the differences that exist in codes but many of these arguments are based on personal bias and are not scientifically justifiable. The Federal Building Code is not likely to be accepted in the near future because of opposition from the fragmented building industry which has united against it. An interstate code seems to be preferred to a national code.

Dr. Otto Klima, Vice President and General Manager of the Reentry and Environmental Systems Division of the General Electric Company, Philadelphia, gave an incisive review of the General Electric Modular Home Program.

Mr Eugene Brooks, Director, and Mr. Issac Adams of the Watts Urban Workshop, gave a seminar on the many problems facing low-income minorities groups in the urban areas.

Comment on Speakers' Remarks

Land, labor, loans, and lumber are four basic problem areas facing the housing industry. Practically all remarks made by the seminar speakers fell into one of those categories. The great issues of today are of an interactive social and technological nature, and housing is at the core of these issues. Even a casual reading of the speakers' remarks suggests that there are many differences as well as concurrences of opinion as to how one goes

about solving the housing problem in this country. Because it would require an extensive report to present an in-depth critique of the speaker's remarks, only a few salient observations will be given. For instance, many speakers stressed that the adoption of enforceable performance specifications in the building codes which they feel would be an important step in promoting technological innovation in the building industry. The rather rigid building codes of today, which often lists specific materials that must be used in the construction of homes, makes it all but impossible for manufacturers to introduce new construction materials and methods into housing.

The adoption of greater code uniformity throughout the nation seems to be considered a desirable goal to reach. One modular home manufacturer indicated that they could save at least 10 percent on the cost of a home if the building codes were more uniform. Other modular home manufacturers have speculated that the cost of the home module could be reduced by 50 percent by using mass production techniques and new technology. All speakers speculated that not only would the cost of the home be reduced but that the quality of construction would be improved markedly.

Other speakers were not so optimistic that reduction of the cost for housing would ever become a reality. They indicated that the price of land is a dominant factor in causing the increase in housing costs and that financing costs also significantly influence the increasing financial burden of home ownership. It is apparent that the housing problem is a vast one and seems to be almost beyond the ability of man. Everyone recognizes the primary problems to be so-called people problems and people problems should certainly not be considered to be insoluble. Only after the social problems are identified and solutions are indicated can technology be expected to provide a meaningful impact toward a total solution.

Program Objective

The NASA-ASEE Summer Faculty Fellowship Program in Engineering Systems Design Brochure gave the following description of the program that was to be conducted at the Marshall Space Flight Center in conjunction with Auburn University: "System design employing space-age materials and technology for future housing and environment." Before coming to Huntsville, the participants had several opinions as to what they were going to do on the summer program. About one-half of the participants felt that they would either design new hardware or apply NASA hardware to the needs of the housing industry. Others felt they would be designing a house from the standpoint

of styling rather than detailed involvement with construction methods or hardware. Some participants felt that they would be involved in designing a new town or city while two assumed they would develop a mathematical model of some aspect of the housing problem. Finally, some felt they would be involved in the development of an industrialized housing system or perhaps generating some sort of policy on housing from the viewpoint of the national scene. As expected, there were those who had more than one opinion as to what their summer activity would be.

It seemed obvious that since so many of the participants felt originally that they would be applying NASA or aerospace hardware to the building of a home or its components, that this topic would be chosen as the objective for the summer program. After all, much effort has been expended in trying to pinpoint and identify specific NASA or aerospace contributions or spinoffs that have application in the consumer market. Unfortunately, the results of these efforts have not been convincing. Why? Has not the NASA effort contributed to the development of microelectronics, computers, medical advances, communication satellites, earth resources and weather satellites, laboratory satellites, precision instrumentation, flat conductors, insulation materials, fireproof materials, proven managment techniques, etc.? Even though such a question defies an easy answer, several points seem obvious to the most casual observer: (1) No one doubts that NASA and the aerospace industry have made a positive contribution to the technology of the civilian economy; (2) there has always been and probably always will be a large time lag in technology transference. It is not always easy, obvious, or inexpensive to adopt an idea or piece of hardware developed for one application to another area of endeaver; and (3) priorities of some sort must be established for the expenditure of our national resources.

Some questions arise as a result of establishing the previous points. Is society too impatient at the time delay between scientific discovery and engineering applications and their practical use to the layman? Is private enterprise incapable of accepting the financial risks in technology transference and, if so, should the Federal Government support this effort? Should an agency such as NASA have to justify its primary mission, which may not show an immediate monetary return, by accepting a secondary mission that promises to show a near-term profit?

Although it is not clear who should attempt to make the transference of technology, it is clear that such an attempt should be made because there are severe problems that need to be solved. Low-cost, effective control of all forms of pollution, weather, insects, pestilences, food supply, and poverty,

along with providing a decent home are indeed noble goals toward which the technologist can contribute. Hard technology was bypassed and another topic was selected because the building of a house or the application of existing technology to the housing industry is really not at the core of the problem of how to bring about better housing for everyone. The topic as chosen by the participants during the seventh week of the program was "STARSITE - Toward a Decisionmaking Process for Housing." The participants began to realize that although many people were quite knowledgeable in certain phases of the housing and environmental problems, there did not seem to be a mechanism for making decisions. The participants felt strongly that before progress could be made in solving the vast housing problem, particularly in the urban areas, one must view the problem from a national or an overall viewpoint. First, a national policy with a decision-making mechanism must be established. Then and only then can a meaningful approach be made to apply hard technology to carry out the implementation per policy guidelines. The efforts of the participants were thus directed toward organizing a body of information and writing a report that would assist others to see what some of the problems are and what needs to be looked into first. To minimize frustrations and to avoid wasting national resources, a piecemeal or fragmented attack on the housing problem should be avoided. Segmented programs not in proper perspective or in harmony with an overall national program often result in wasted effort and money and, even worse, the dashing of the hopes and promises of many people.

Often, innovations in methods and application of new materials are stymied unless certain laws, codes, human opinions (for instance, that of the building inspectors), and the mores of society are in part changed or re-educated. Once the decision-making mechanism that would allow manufacturers the freedom to use new technology on a competitive basis with other technology is established, then aerospace and NASA technology will be engineered for the housing market. If ideas such as the introduction of performance specifications are widely adopted in the construction of housing then the engineering talent of this country can be brought to bear on applying the spinoff of space technology to the earth based housing problems.

In summary, the participants felt that although some NASA-developed hardware is finding its way into the consumer area, including the housing industry, emphasis in this report is directed to the soft hardware developed by NASA; i.e., modern management techniques. The summer faculty fellows felt that the management methods developed by NASA which were successfully

applied to a large problem such as the space program leave little reason to doubt that these same techniques can be brought to bear on other problems such as that of housing. The application of hardware, including that of NASA, is of secondary importance and follows in a natural, evolutionary way once policy is established and decisions are made.

Page Intentionally Left Blank

CHAPTER I

INTRODUCTION

CHAPTER I. INTRODUCTION

Quotation

"A decent home and sutiable living environment for every American family" was the praiseworthy national policy of the Congress of the United States pronounced in the Housing Act of 1949.

Problem Statement

Housing is important to our nation's well-being, and it represents a sector of our economy where major social and economic benefits can be developed. The housing dilemma continues notwithstanding the attempts of government, institutions, and private industries efforts toward solutions. It continues because the housing problem is related to many other problems facing our nation and it continues because policy, resource allocation, and decision-making criteria to accomplish stated objectives have not been established in a methodological approach.

Housing Problem Scope

Housing, in itself, is a complex system and occupies a very central place in peoples' lives. The way in which a family uses its house and environment is intimately meshed with its most basic values, and because human values vary, so do housing requirements. Furthermore, when added to the economic, social, and political factors that surround and influence housing, one recognizes the extensiveness of the total housing system. These factors have operated to improve housing and its concomittant services for some users, yet many have been forced by these same factors to live in grossly substandard housing..

American families, upon acquiring the wherewithal, have generally moved to suburbia. Many influences, including governement programs, have provided and stimulated this trend. Notwithstanding the rejection of middle class values by the present youth culture, the relocation from urban areas continues unabated and is now giving rise to associated difficulties. Social and financial problems are beginning to emerge in communities that were, until recently, viable and attractive. Suburbia's needs should not be overlooked, but most of the real problems are in the urban areas: housing, poverty, social alienation and conflict, the breakdown of services, and the deterioration of the social and physical environments, to mention a few.

In the 20 years prior to 1968, the housing industry had produced over 30 million new housing units, but of this total, fewer than 1 million units were for poor families. The success of much of this new housing has been spotty, partly because of the lack of attention given to sound, comprehensive planning. Many people have been moved and communities disbanded by design. The Douglas Commission report on the Department of Housing and Urban Development, which was released in December 1968, indicated that:

1. Urban renewal had destroyed 400 000 living units for the poor and provided sites for only 20 000 public units.

2. Over one-half of the public housing units built were either efficiency or 1-bedroom units.

The institutions and industries that are directly concerned with housing have not yet produced changes that reflect their potential contributions. Housing production is up; however, according to other sources and measures we are losing ground. The complexities of the housing product reflect a much wider range of physiological, psychological, and social needs for the dwelling user than are generally considered by present housing system products. In addition, housing programs that are poorly conceived and implemented ofttimes benefit the user less than the intermediaries that make it all possible.

In 1968, Congress issued quantitative housing goals. The goals projected for the next decade were 26 million dwelling units of which 6 million were to be for low-income families. The implementation of the declared policy was not specified.

The goals would require a rate of construction nearly double that previously attained and would face a drastic diversion of resources toward housing construction, an expanded program of assistance and subsidies for low-income people, the overcoming of institutional constraints, and, more recently, the demands for "a piece of the action" by minority groups with respect to their housing. To be worthy of a national commitment, the housing goals must be approached in view of the social, economic, and political systems of which it is a part. Housing, particularly for low-income people, involves some of the most controversial social, economic, and political problems of our time; civil rights, open housing, the question of whether to use housing as a tool for dispersing or for further concentrating low-income people, and a redistribution of income by various means.

The provision of housing in the United States is approximately a $50 billion per year industry, and constitutes one of the nation's largest industries. Today, the industry is popularly characterized as backward, highly fractionated, and involving a large number of small labor-intensive local businesses. Whereas, in 1963, the Sub-Panel on Housing reported to the Panel on Civilian Technology Office of Science and Technology Executive Office of the President, that in the prior 15 years the residential building industry had made impressive gains in meeting the nation's pent-up-housing needs. Furthermore, in the process, it developed into a local well-organized industry, with many important innovations being introduced ranging from finance to technology. The major criticisms of the present industry are partly because of its inability to provide housing for low-income groups and, in general, provide housing that supports the aspirations of all economic and social groups within our society. Also, housing has failed to contribute as much as it might to national economic growth.

Housing starts per thousand population averaged 7.5 during the years 1961 - 1968 compared with 7.8 during the years 1953 - 1960. The value of residential construction as a percent of GNP for these years is shown in Figure I-1. The "credit crunch" of 1966 was primarily responsible for a 20 percent cutback in housing starts from the previous year. There was no comparable impact on other sectors of the economy. A similar situation occurred again in 1970. The question, of course, is how well monetary and fiscal policies are integrated with housing policies. An overall systems view would suggest approaches which would allow policy and decision-making selections that would not unduly burden any one economic sector.

Approach to Solution

From the onset, we have utilized the systems approach philosophy in attempting to identify the components that occur in the housing system, and the relationships and environment in which they operate. During this process, areas were evidenced in which technological innovations could be useful and indeed possible with the present state-of-the-art. Although valuable in themselves, consideration of the implications of technological change and the needs for this change have forced us to take a broader view of the housing system. It also became clear that the existing housing system does not exhibit an identifiable rationale to determine the merits of a specific change, its performance requirements, and methods of measurement. History has shown that the actual performance of a change, including those of a technical nature, are less predictable than decisionmakers would desire. This is largely

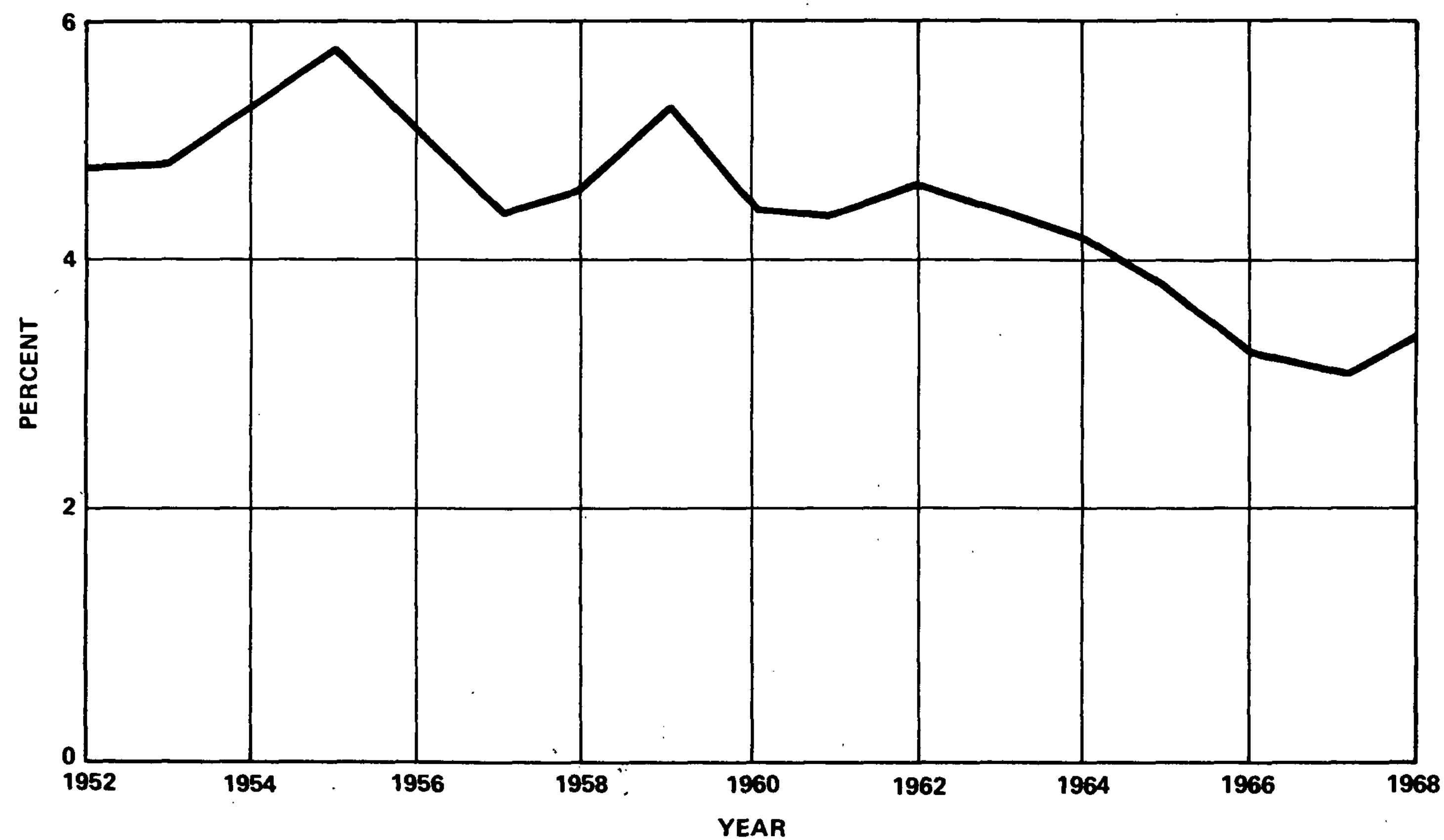


Figure I-1. Value of residential construction as a percent of GNP — 1952-1968

because of the fact that the housing system is a complex interaction among many different subsystems that come together under conditions and in a manner that is known to the decisionmaker often only in retrospect, or not known at all.

There is no one solution to a housing problem and likewise there is no one housing problem. The pertinent housing problems extend beyond the scope of any one Federal, State, or Local Department's jurisdiction. Further, institutions, private industry, and individuals cannot effectively perform alone. There seems to be, therefore, justification for concluding that all elements mentioned above must work cooperatively with a clear picture of their objectives and an understanding of their respective roles and responsibilities.

All elements in their operation at various levels make policy and decisions and, therefore, a methodology must be available to assist administrators and others in assessing the housing system's performance and to evaluate the effects of policy and various approaches in accomplishing housing objectives.

It is well to point out some facts that often are not appreciated in the application of system technologies to the problems that traditionally have fallen into other domains. Firstly, the characteristics of these problems are such that a comprehensive understanding requires an interdisciplinary approach. An important outcome of this requirement is the development of qualitative and quantitative descriptors of the interrelationships between the component parts of the system, ofttimes providing original insights and data on these component interfaces. In this vein, it is interesting to note that many instances of housing failures have been blamed on untoward secondary effects which in reality are unanticipated responses and adjustments of other components of the system. Secondly, in some applications of the systems approach, the process is organized purposely to create the system, and in this sense, it is a unique system. In other applications, we are dealing with existing systems and, therefore, need first to understand the system. The perspective is developed by organizing the existing system in scope and character. Although there may be elements and interrelationships that are not of a quantitative deterministic nature, qualitative and/or statistical properties can be ascribed for the purpose of system evaluation. In this regard, the system is better understood and provides an organized means of assisting in the decisionmaking process.

The Auburn design approach to the housing system represents a formally organized means to understand the system, and a methodology that will permit alternative investigations to assist in decisionmaking and implementation.

The housing system can evolve in an aura of uncertainty, or alternatively by directed evolution. We prefer the latter possiblility and set about to model a decision-making process for housing.

The organization of the housing system, as we see it, is depicted by the family of diagrams in Chapter III. The planning and evaluation model is developed in Chapter VIII.

CHAPTER II.

HISTORICAL OVERVIEW OF HOUSING

CHAPTER II. HISTORICAL OVERVIEW OF HOUSING

Introduction

Growth and Development of Housing. A quick survey of the history of American architecture reveals quite candidly the emphasis that housing has played in the growth and development of America. In the country's early days, shelter was such a basic need that the production of housing occupied a significant labor effort. Consistent with this early effort was a developing spirit for community building. The planning of both homes and cities is consistent with our country's earliest goals and forms an integral part of our inheritance. Examples of early planning efforts are many, including New Haven, Connecticut, in 1641 and Savannah, Georgia, in 1733. Both of these plans set aside public open space. The New England example utilizes a central square for public functions with the residences lining the streets on a gridiron pattern. In Savannah, the concept developed was of a series of green squares about which the principle residences were built. This pattern allowed for growth by repetition, producing a very humanly scaled community. It is too bad that this concept was not repeated more often in the cities that followed [II-1].

William Penn's plan for Philadelphia in 1682, again a grid of streets on which to build houses and with green squares judiciously spaced, seemed to provide the typical direction which the planning of America cities would take. The houses are lined up on either side of the street, perhaps with trees in front of them, producing a crisp domestic scheme that extends livability from the private to public areas through a filtering mechanism [II-2]. Even the country houses bear evidence of formalized geometrical placing and are enhanced by the planting of entrance avenues. As the West developed during the nineteenth century the gridiron plan jumped in scale to encompass whole regions of the country using the mile as a basic unit measure.

House as a Part of American Culture. Emphasis should be placed on recognizing the quality aspect of our early home building activity. The interest in building not only homes but a country is significantly consistent. The author of the Declaration of Independence, Thomas Jefferson, worked hard to perfect the design for his residence. Sir Kenneth Clark in his Civilization gives a strong sense of its importance by saying: "Monti Cello [II-3] was the beginning of that simple almost rustic, classicism that stretches right up the eastern seaboard of America, and lasted for 100 years producing a body of

civilized, domestic architecture equal to any in the world." The influence on building of the Federal Period including its architecture and decorative arts cannot be overstated. Witness the series of revivals of classicism, even though somewhat watered-down. During the Federal Period circa 1790-1820, it was argued that interpreted classic forms were not only appropriate but right for the new nation equaling Greek and Roman Government ideals of republican democracy and, furthermore, carrying the influence to life style.

The Changing Aesthetic. This influence on aesthetics can still be felt. This century has seen, however, a broadly based emphasis for change. It has been called modern architecture, and, on the domestic side, was most prominently expressed by Frank Lloyd Wright, a very prolific and influential residential architect. Equating the ideas of democracy with nature, he built his prairie houses of locally found materials and emphasized horizonality in their structural form. Open planning of spaces related directly to the out of doors created an envelope for life style exemplary of the basic goals. Contemporary with this effort, though primarily influenced from abroad, was a conscious development of the tools and materials of the machine age. The basic residential idea was to build a "machine for living." The corollary idea was that it should not only be slick looking, being built of machined parts, but that it should actually be built in an industrialized manner.

Statement of the American Perspective Toward Housing

While all of this theory was being formulated and experimented with on a limited scale, America kept building houses, expanding her cities into a limitless suburbia, and utilizing techniques of "stick-built" construction that are medieval if not ancient in their historical origin. In fact, the last big breakthrough structurally was the "balloon frame" that, by the invention of nails and the sawmill, was made possible in the early nineteenth century. Refinements in plumbing and energy distribution have made strong contributions to the rather static framework for livability.

The American Housing Pattern. The American housing pattern appears to be composed of three major components. The custom designed element is the smallest segment. The efforts of architects fall primarily into this class, as exemplified by those of Frank Lloyd Wright or even Jefferson. Their efforts have had some influence, though usually diluted, on an even larger segment of the real estate market; i. e. the speculative or "house for sale" element. Herein lies a very conservative body of builders, developers, and promoters who operate on a vast scale dependent solely on the salability of their product. Only tried and true techniques can be afforded.
Though much of the sales appeal is transparent in a rational sense,

it is hard to knock the success of this multibillion dollar industry. The third component is the rental element of the market which is probably the largest segment. Here again, conservatism applies to the design of the product, but to a somewhat lesser degree than previously stated, because of the shorter duration of contractual obligation. A greater degree of client universality is interpreted as flexibility to user needs but usually means at best internal blandness. Externally, emphasis on sales appeal is included in the list of amenities offered. Rental properties including the special cases for low-income, elderly, transient, infirm, etc. , are usually seen to be great piles of brick and mortar built as monuments to obsolescence. Even those for the exclusive element of society tend only to amplify these factors.

Failing Of The American Dream. The great American dream for housing has been a failure. Even some of the theory now seems questionable. Wright's broad-acre concept simply used too much land. Density ideas need much study.

If this analysis of the failure of the American dreams holds any truth, it may not be as bad as it seems. Concurrently, a lull in traditional construction caused by complex economic pressures exists. This winding down of housing production can be seen, despite increased demands for housing. New family formations are on the rise. Mobility is up. Statistically, the market picture seems fantastic. It is a good time to question many of the long-held rules of the trade and the demands of the buying public. One rule to question is the viability of the single-family dwelling unit concept in urban areas. This idea of "little estates" is an outgrowth of the concept that a man's home is his castle, his protection from the world, and is held to be dear. Technology has advanced the state of the art. Its application to housing production seems more than imminent.

Architectural Theory Versus Practice. Architects have exhibited interest in industrialized construction techniques, but rarely have contributed to the solutions of the problems involved. Much of their efforts stems from the not-inconsiderable effect of their early day mentors such as Corbusier, Walter Gropius, and Mies van der Rohe. For one thing, most of their efforts have been related to single buildings, each custom designed. This immediately denies the possibility of true industrialization, at least in terms of classical industrial concepts now under discussion. Even in those instances such as design and building of single or small groups of light steel frame and in-fill panel residences, where the mix of skills on the job is different from that of traditional "stick building" and where much more shop fabrication (e.g. , the steel frame) and on-site prefabrication (panels) may be involved, the job is

still essentially developed by traditional means. Therefore, even earnest efforts in this area were doomed to higher costs because of the unique nature of the structure, unfamiliarity, etc. Also, realistically speaking, while an advantage was often taken of the unique characteristics and capabilities of some of the newer materials, more often than not, an abiding interest in the physical form would result in extreme underutilization of some of those capabilities to achieve other ends. In addition, the architect's efforts have been frustrated by the same inhibiting factors such as those now containing larger scale attempts at industrialization; e.g., dated and prescriptive codes and labor, jurisdictional arrangements, and conservative reaction by consumers and financial institutions. Often, technology at the time was not developed sufficiently to allow direct expression of industrially produced building components. Thus, we saw in a series of apartment towers by Mies van der Rohe the curious situation of a structural steel frame being fireproofed with a protective concrete enclosure (only to have steel wide flange members or steel plate covering applied to the exterior of that coated frame) ostensibly to provide an expression of the real structure within. Today, improved testing and development of new fire codes (more sensitive, for instance, to the fact that fire danger in high-rise building exists primarily from within) as well as unique means of fire protection now have begun to facilitate the exterior use of unprotected steel.

The actual result of most architects' efforts in this area of endeavor has been to create visual expressions of an industrial age in a sculptural rather than a structural sense. To the degree to which these efforts have assisted in the visual education of the consuming public, which continues to insist upon some sort of expression of traditional forms from another age (even at the additional expense of having it "glued on") while being fully capable of accepting and appreciating contemporary design in automobiles and airplanes in a distinct service, has been performed by these architects.

On the other hand, there are some architects who have actively pursued true industrialization of the construction process, such as Carl Koch with his Techcrete System, Neil Mitchell and his Mitchell Framing System, and Moshe Safdie in the system now developing out of his earlier efforts with Habitant. Other practitioners have attempted to use some industrially produced components (beyond the accepted kind such as HVAC units) and even full systems in the design of their buildings. It is sufficient to note for now that the result of these endeavors has considerably changed the traditional nature of their professional practice. In some instances, they have become entrepreneurs, and other instances they have become manufacturers, and, occasionally, they become both.

It should also be noted that the profession, in general, over the years has been at the forefront of many of the individual innovations in buildings. These, while not coming under the aegis of organized, industrialized processes per se, in their sum total, comprise the history of advances in this area. These innovations comprise not only technological changes, such as structure and mechanical/electrical systems, but in social, psychological, and spatial characteristics of the built environment as well. They have played a significant part in the rationalizing of building, together with users, developers, and constructors.

Contemporary Examples. Contemporary examples can be cited which show efforts to apply technological innovation to housing production. These efforts broaden the perspective of the American attitude toward acceptance of technological applications; however, the real question is whether the buying public wants this. A visible expression of change has not generally been accepted. The stakes for experimenting are high and failure has proven costly.

The situation is not unlike that of the Habitat project at EXPO 67. That project, a failure in perhaps every way but one, may in the end have been worth that one achievement. It caught the imagination of the North American public and gave it form. In addition, the incorporation of unusual forms in Habitat such as pedestrian "streets" and other amenities as integral architectural elements was one of the first concrete examples of urban design concepts being applied to the design of large-scale building projects.

Industrialized building has also pursued more traditional avenues of marketing. Housing developers admit that they do not initiate innovations in housing concepts, architectural design, and use of materials within their own developments. Rather, they prefer to leave the risk and the cost of such innovation to the custom home clients and their architects and engineers. As the developers themselves put it, "they will then await the appearance of these houses and the innovations they incorporate, in the Sunday supplements and slick-paper pages of the consumer-oriented home and garden magazines." From the response that is thereby generated as well as the specific answers to spot surveys made at the model homes of their own subdivisions, they can then guage the salability and therefore the usefulness of incorporating certain of those innovations in follow-on models of their own products. In some instances, the incorporation of a single such innovation has led to instant financial success. Witness the "patio kitchen" by the old Deane Brothers organization. Architects are often amused at the propensity of some of those developers to claim credit for the creative invention of those "innovation." On the other hand, clients of those architects who have paid the original

"development costs" for such innovations are sometimes less amused by such claims. In many instances, the innovation, when it "filters down" to its final form of incorporation in housing tracts, is often less than recognizable and architects are happy to let the developers take credit for it.

The appearance of Environmental Systems International's H-formed modular in a recent issue of the Los Angeles Times Sunday Home Magazine is therefore significant. Replete with sliding glass doors, outside as well as partially enclosed patios, heavy wood trellises and other skillful forms of spatial limitation "camouflage, all in glorious color," it should generate a good deal of reader response and interest.

Equally significant for the same reasons is a similar H-formed (but vaulted ceilinged) modular sponsored by Family Circle Magazine and the American Plywood Association and first shown in November, 1970, at IBEC/70 in Louisville, Kentucky. The March 1971 issue of Family Circle Magazine ("available at your supermarket checkout counter") features it in a 14-page spread as "Family Circle's Mobile Modular for 1971 - A new Concept in Housing." The color photography manages to depict the maximum 11-ft widths of the interior spaces at such breathtaking expanses as to be considered one of the finest examples of the architectural photographer's wizardry. The article closes, as one might expect, with "where to buy it" information. (Their modular is actually manufactured and marketing by one of the largest national companies in the mobile/modular business - the Commodore Corporation.)

Housing Goals

Past Goals — A Decent Home, 1949-1968. Historically, the government has been actively influential in the affairs of housing since the New Deal era of the 1930's. It was in the 1949 Housing Act that Congress explicitly stated the American Housing Goal to be "a decent home and a suitable living environment for every American family." This goal has since been consistently reaffirmed, recognizing that it has not been met. In the 1968 Housing Act, it was quantified based on statistical projections as requiring a 10-year production of 26 million units. Much effort and study related to the meeting of this goal has been undertaken. The traditional housing industry in almost any measurable sense is lagging behind. The availability of funding for this goal is also lagging [II-4, II-5].

Lawrence A. Mayer has characterized the nature of the housing shortage in his December 1969 FORTUNE article "The Housing Shortage Goes Critical" as follows:

"A housing crisis is building up in the U. S. The shortage of acceptable shelter that has long been afflicting the poor and the black is spreading to the white middle-class and even to quite affluent families. It may be that conditions are at their worst right now. But a real turnaround will not come quickly, for the housing industry is at present simply not well enough organized or well enough financed to make rapid solutions possible. Chronic problems are going to linger on until the U. S. decides to give housing a high national priority. The unmet needs that piled up gradually in recent years have suddenly gone critical."

Meyer and a significant number of equally pessimistic fellow observers of the U. S. construction and housing scene can point to a large variety of existing conditions upon which they base their outlook. The national goal of 26 million would appear to be a very large order under the best of conditions, a buildup period would be expected and an average yearly rate would only indicate industry's ability to catch up to the total at the end of the decade. When one considers that actual production for the first year, 1969, was 1.5 million units [II-6] and that an optimistic projection for 1970 according to Harold Finger, Assistant Secretary for Research and Development at HUD, is pegged at 1.4 million units [II-7], it becomes evident that what is involved is not an initial catch-up period but a desperate keep-up attempt. In HUD secretary George Romney's words, "We're losing ground every year. We're not even building enough to stand still [II-8]."

The fact that in the future, Mobile Home "Starts," which reached 400 000 units in 1969 [II-9], will be included by the Administration in the annual production figures would seem to be a measure of the Federal Government's concern, if not despair, over reaching its stated production goals.

The nature of our past record is somewhat revealing. In the past decade, 14 million new housing units were built. Considering that 24 of the 26 million "national goal" units are planned to be new housing starts, we are calling for an additional 10 million units to be built in an equivalent 10-year period. (The remaining 2 million units are to be rehabilitated existing structures.)

Reviewing the government's own past record in the area of subsidized housing, including public housing and its larger refined versions, the chances for 4 million subsidized new units and 2 million subsidized rehabilitated units for low/middle income needs look equally dismal [II-10]. Various writers

often recall that the Housing Act of 1949 called for 800 000 public housing units by 1955. Today, 20 years later, a little over half of those authorized in 1949 have actually been built [II-11]. In reality, the past 3 decades have produced a total of only 700 000 units of which 400 000 were conventional public housing and 300 000 were 221d (3), rehabilitated units, senior citizens' housing, and low-income projects. The most productive year of government activity in the production of low-income housing was 1968, when 120 000 such units were produced. That amounted to only 15 percent of the low-income housing need projected for that year by the government. Further, it is now generally acknowledged by most all sources that, as the Douglas Commission reports,

> "Through private enterprise but with FHA programs and other government incentives, since World War II, we have provided a phenomenal amount of housing for the middle and affluent classes, mainly at the edges of the central cities and the suburbs. At the same time, through these and other more general government programs of urban renewal, highway construction, demolition on public housing sites, etc., we have destroyed more housing for the poor than government at all levels has built for them [II-12]."

The total sum of the nature of the existing situation may be summarized by indicating that since 1966 the number of houses and apartments actually built have fallen well short of basic housing requirements. Thus, each year, the situation has been increasingly compounded. It is growing steadily worse by the year [II-13]. Since the national goal of 26 million units was developed from these basic requirements, it might be well to know what they are.

Harold Finger has claimed that, contrary to some recent expressions of doubt, the goal of 26 million units was not "a number pulled from a hat, but was based on some pretty good demographic projections [II-14]." Most of the literature tends to be pretty consistent in this area. By 1975, the projected increase in U. S. population is 14 percent, for a total of 227 929 000. (By way of contrast, the more frequently seen figure for the year 2000 of a 69-percent increase to 338 million is in more open dispute and may shortly be revised somewhat downward.) The expanding population projection for 1975 provides the basis for the initial basic requirement: "net additional household formation." The second usually is termed "replacement;" e.g., units required to replace or rehabilitate housing now considered substandard or dilapidated or projected to become so over the decade. The third requirement is to maintain or permit the necessary number of vacant units. This last is required so that the housing market may function normally in accommodating society's general mobility; i.e., the frictional needs of the housing market [II-15].

Some Aspects of the Problem. In microterms of the construction industry itself, reasons for this broad disparity between what we have produced, what we are now producing, what it looks like we will be able to produce and what we say, as a new national commitment, we must produce in the next decade, has been attributed to a wide variety of reasons. Most sources, although differing in emphasis, would agree to most of the following difficulties:

1. Rising costs of land and increasingly limited supply of land in urban areas.

2. A conflicting, often restrictive zoning and land-use pattern over the country.

3. Restrictive specification rather than performance-type building codes and other government regulations and policies, especially spiraling property taxes; again, all at great variance throughout the country.

4. Rising cost of materials and labor and, particularly in terms of the latter, increasing scarcity. Also, restrictive policies and control arrangements by labor.

5. High cost and scarcity of construction funds and long-term financing.

Other factors such as the fragmented, roller-coaster nature of the market, the existing, equally fragmented nature of the industry, resistance to change and innovation by elements of the industry and by the consumer, lack of research and development within the industry, and the unique immobile nature of the industry's product are equally important components of the problem.

Presently, about two-thirds of our population lives in cities [II-16]. Over the next 20 years, through population increases and subsequent new net household formation and through migration (largely internal, rural to city), it has been projected that we will add 70 million people to our cities. In this on-going process, we convert over 1 million acres of land each year from rural-agricultural activities to urban uses [II-17]. The cost of providing services to this new, primarily suburban growth and the limitations of these services have combined to produce pressures for increased densities and more intensive land used in the urban centers themselves. These elements are reflected by the fact that, by FHA figures, urban/suburban land costs have risen 57 percent in the last decade [II-18]. The cost of urban land in

1969 rose 10 to 25 percent over that of 1968 [II-19]. The rising cost of land and the densities implied, if the trend towards urbanization continues, bear significant implication upon the kinds of new housing that might be required.

Perhaps one of the most significant factors in the decreasing amount of present construction has to do with financing, including short term borrowing by builders and developers to finance the cost of construction and long-term borrowing by the buyer/owner to pay for that cost and the developers' overhead and profit. Demands from all sectors of the economy upon money markets have created the present tight-money situation and subsequent rise in the cost of using what funds are available. The result is a sharp rise in interest rates from 4- to 5-percent level in the early 1960's to peaks of over 9 percent, some of the highest cost for housing money in our history, and the situation shows only tentative signs of stabilizing. The scarcity and high cost of money is the most recurrent factor to which the dramatic slowdown in construction activity is attributed [II-20].

Even if both land and money were relatively inexpensive and available in ample amounts, another shortage is an equally constraining factor. The construction labor force was estimated at the end of 1969 to consist of 2 860 000 workers. During the 3 years previous, it had grown by less than 3 percent [II-21] (as opposed to the national industry work force average of approximately 10 percent). The situation has become serious enough to reflect itself in the practice of "pirating" skilled labor tradesmen, not unlike that which occurred in the electronics industry a few years ago. More concrete evidence of the seriousness of this shortage is that while the cost of materials has generally gone up only about 1 percent per year (and in some instances, even dropped) the cost of skilled on-site construction has had successive annual increases of 12 to 15 percent per year, including both wages and benefits. This is in spite of the fact that less than 50 percent of the work force is unionized. Thus, even if, as some studies show, labor productivity in construction may increase in some cases by as much as 2 percent per year, this nowhere nearly offsets those wage increases. By some estimates, this single factor alone accounts for an increase in overall housing costs of 3 to 4 percent per year [II-22]. The problem can be viewed in another way. A 1969 survey by Owens-Corning of 17 cities showed that the construction of a house took 1 to 6 weeks longer than the year before, with the most reoccurring reason being given as the shortage of skilled labor [II-23]. The scarcity of labor is even more significant in terms of the national goal. With our present labor force and a likely return to a 3- to 4-percent unemployment rate if the economy stablizes, where will the required work force come from? With the current force of construction workers and present methods of construction, it is estimated that with all factors favorable, at the maximum, we could produce 1.8 mil-

lion dwelling units per year [II-24]. If, somehow, decreasing participation in apprenticeship programs would be reversed and restrictive hiring practices significantly relaxed, which is unlikely, then the trend of increasing shortages in the highly skilled carpentry, plumbing, electrical, and sheet metal trades could begin to be reversed. Even so, most experts doubt that sufficient number of people could be found, much less trained, in time to get private building up to a sustained rate of even 2 million dwelling units by 1972. That fact does not even consider the corollary increases in skilled labor requirements for rehabilitation of existing structures plus that required for new government housing programs and related educational, highway, sanitary, commercial, and industrial facilities that must accompany significant increases in home building [II-25]. For that reason, many builders believe that any sudden leap toward a 2.6-million dwelling unit production without substantially increasing the present labor pool and/or revising present construction methods would very sharply increase already inflated construction costs [II-26]. If a production boost of 1 million additional units per year were possible, at (as we shall see, an unrealistic) assumed cost of $20 000 per unit, this would then imply an annual increase in construction expenditures of $20 billion per year, assuming constant wage and material costs. But, due to increased demand upon labor and materials, the latter would probably raise the cost of that unit by 20 to 30 percent, requiring an annual increase in housing outlay on the order of $ 30 billion or more [II-27].

Many critics have also expressed concern that not enough attention has been paid to keeping our existing stock of 66 million housing units in shape. It was estimated by the Kaiser Commission in 1968 that 6.7 million occupied units are substandard (4 million without indoor plumbing and 2.7 million in dilapidated condition). With approximately 60 million households in 1968, there were 6 million vacancies which was, at that time, the nation's lowest vacancy rate since 1958. Of those vacant units, only about 2 million were in standard condition and available for occupancy [II-28]. The number of substandard units literally abandoned by their owners each year because of rising costs of upkeep and runaway taxes, particularly in New York City, makes for a now familiar news item. As Morton Isler, housing program manager at the Urban Institute puts it, "Landlords and public housing authorities are running in the red and cannot provide proper maintenance. We are loosing good buildings faster than we can replace them [II-29]."

The significance of large numerical values as has been cited in previous paragraphs tends to become obscure as their scale and number increase. Thus, many writers have translated these large quantities into terms that become more

meaningful. As an example, in 1968, about 7.8 million American families, about one in every eight, could not afford to pay the market price for existing standard housing that would cost no more than 20 percent of their total incomes. (About half of these families were surviving on less than $3000 per year, the federal poverty level.) The average ratio of housing costs to gross income for the total population is 15 percent. Parenthetically, one traditional industry source points out that this is less than any industrially advanced nation in the world, including India [II-30]. The point is made apparently to suggest that the problem of inadequate housing is not only one of the existing industry's ability to meet national needs but also one of the American public being unwilling to pay what it should for shelter.

Beyond the problems of the existing housing stock, what of the cost of new construction? According to one investigation, the cost of urban housing construction excluding land rose as much as 40 percent between 1961 and 1969 [II 31]. Between 1968 and 1969 alone, the increase was 10 percent [II-32]. One large New York homebuilder estimated that between 1967 and 1969, his cost rose by 1 percent per month and that no decrease was in sight [II-33].

When put in terms of final price to the individual buyer, it immediately becomes evident that the crisis is no longer confined to those with poverty level incomes. According to Michael Tenser, Senior Vice President of the Los Angeles based Larwin Group, one of the nation's largest home builders, a house in 1966 sold for $25 000 required a family income of $9000 per annum. Forty-one percent of the population could qualify at that time. The same house in 1970 cost $32 000 and requires a family income of $14 900 per annum. Only 22 percent of the population qualifies [II-34]. According to R. J. Weiss of the nation's largest housing producer, Boise-Cascade, the average house financed by the savings and loan industry was priced at more than $30 000. The median-priced home was $26 000 [II-35]. As Harold Finger pointed out, this price requires a family income substantially about the median American income. The average American working man simply cannot handle the payments [II-36]. A recent study of major American cities in 1969 put the average price of homes financed on conventional mortages at $35 100 as of May 1969, an average of $5000 or 15 percent higher than the previous year [II-37].

The rapidly escalating market price is not the only factor putting the average new home out of reach of the average American. The financing picture when considered in terms of the individual buyer is similarly revealing. Even on a $25 000 mortage, a 1.25-percent rise in the interest rate over the previous years' average adds $20 to the monthly carrying charges. The average rate went from 6.5 percent in 1967 to over 7 percent in 1968, then to 8.4 percent in 1969 and now can be over 9 percent. On the other hand, in

1969, at least 22 states had usury laws on the books that restricted maximum interest rates to 8 percent on consumer contracts. (The FHA/VA limit in 1969 was 7.5 percent.) These kinds of limitations plus general competition for limited funds creates a dilemma. The lending institutions obviously wish to put their money out at the highest possible rate. They also, in a period of steadily rising inflation, wish to avoid being paid back, over the long term, in cheaper dollars. Both factors are at least partially ameliorated by almost universal resort, on the part of all lending institutions, to the point system. By this method, for each point charged, 1 percent of the face value of the loan is directly deducted at the time of loan consummation. The institutional effect is to get the actual loan rate closer to prevailing market rates. The effect on the buyer is to increase the actual interest rate by approximately 1/8 percent above the contract rate for every point paid. The prevailing discount being charged in 1969 (particularly on FHA/VA fixed-rate loans which comprise approximately 20 percent of total new home mortgages) was seven points. At the same time, amortization periods were generally decreased from 30 to 25 years, further increasing the buyer's monthly costs. And, finally, down-payment requirements in 1969 were up on the average of $2000 over 1968 requirements, adding still further to those costs [II-38].

While the previous discussion generally referred to the nationwide picture, the situation was equally severe, if not more so, in California. One source claims that a house sold for $14 400 a year or two ago is now selling at $21 000, if it can be found. According to the California Franchise Tax Board records, 4 out of 5 Californians had, at the end of 1968, incomes less than $13 000 per year. It would, therefore, seem that 4 out of 5 Californians cannot afford to purchase a modest home. This may well be the case, although the same source points out that 90 percent of Californians looking for a home are actually renters. Many of these renters are ineligible by FHA standards to purchase a home but they actually pay rent greater than that which would be required for FHA loan payments for purchased housing of comparable levels [II-39].

It should be noted that the sale or purchase of existing homes is put in a similarly squeezed position. The seller must buy or rent elsewhere at the current inflated prices [II-40]. While his existing home, if he has owned it for a sufficient period of time, may carry advantageous financing from an earlier era, he nonetheless must find buyers who can complete the transaction at the going rate (except in those rare cases where he can afford to subordinate or where the existing financing can be transferred to the new owner). During times of tight money, the normal difficulty of financing used homes versus new homes is compounded. Thus, he may elect to stay put unless his job requires moving, thereby decreasing the effective vacancy rate and driving prices up still further.

In point of fact, the same crises situation faces the renters [II-41]. Rents have climbed in as proportionately steep a fashion as home costs. It requires little imagination to realize that hardships equal to if not greater than those facing the buyer face the renter. There is little need to run through cost statistics in the development of residential income property. The results would be similar to that depicted in the case of the single family built-for-sale home.

The effect of restrictive codes and zoning practices are less easily quantified, but no less significant. In part, they are reflected in other factors mentioned previously as equally important components of the problem." These factors, the fragmented nature of the industry resistance to change and innovation by the industry and the consumer, lack of research and development within the industry, and the unique immobile nature of the industry's product, if discussed in detail, would depict a profile of the construction industry as it presently exists. Supporters of the existing industry claim that this profile would but reflect, and adequately, the job it is called upon to do and the problems (some of which we have discussed) that it must face. Others claim that this very profile is in itself one of the primary deterrents to achieving viable solutions to the housing crisis.

The reaction to these problems by the industry has been varied. The $15 000 house has been almost impossible to find. Even the $ 30 000 house has been a rarity in some areas of the nation [II-42]. However, very recently, in an effort to stay alive in the face of these problems, there has been a rush back to the low end of the market where there are still some buyers to be found who are capable of meeting financing terms. That does not imply, however, the low-income market. Rather, what is being offered is a house at current prices that reverses a 15-year trend towards larger, better-equipped homes and apartments; for example, a 2-bedroom house in 1000 ft^2 versus the 1300 ft^2 formerly common (in fact, the return of the 2-bedroom, 1-bath home to the market where, in recent years, the 3 bedroom and more home with two or more baths has long been dominant is in itself significant). These homes are offered on small, more cramped lots and on cheaper land farther from the city. Social critics have viewed the phenomena as a return to "suburban ticky-tack" much like the bungalow production of the 1950's [II-43].

The industry, however, points out that (at least in the past) it has provided Americans with better homes and more inside-outside amenities than those found in any other nation. It has called itself a "small but highly efficient industry" which has managed to double the stock of housing in 20 years in the

face of the most complex business climate faced by any industry. It claims that it has been hampered in its efforts by adverse public policy legislation, including almost the entire brunt of anti-inflation legislation [II-44]. Not only does it see government as the cause of the difficulty, but it also looks to government for solutions to that difficulty. One commentator claims that "The U. S. can afford all the housing it needs with all the goodies and amenities we desire, by allowing increases in residential density and by relaxing mortgage qualification formulas [II-45]."

On the other hand, other industry people feel that private industry, at least in terms of low-income housing, cannot do the job because it must make a profit on what it builds. Also, they claim that local governments cannot because they lack both money and muscle. They feel that the Federal Government can do the job, and in the most equitable way, since its revenue comes primarily from the graduated income tax [II-46]. The industry also believes that the government is suffering from a credibility gap in consistently failing to live up to past promises regarding the housing sector [II-47]. The latter situation, the industry believes, can be rectified by government backing up its verbal committments with a realistic reallocation of resources.

The Federal Government, by its past and more recent pronouncements and legislative acts, has committed itself to aiding in the search for solutions. The significance and effectiveness of that aid will be examined in a discussion of "Roles" and of "Operation Breakthrough" towards the end of this chapter. Presently, it is sufficient to say that housing has also become embedded in the political arena. The Kaiser Commission, in reporting to the President, termed the situation "the worst housing emergency in history." As one observer puts it, "As conventional housing is beyond the reach of most American families of moderate and low-income status, there would seem to be no domestic task facing this nation today which is more demanding or urgent [II-48]." As if to emphasize this contention, recent surveys of low-income families put the need for better housing as second on their "list of worst problems" only to that of dope addiction [II-49]. Pressure on various levels of government to help relieve this crisis is beginning to mount and some observers see housing as taking a place beside pollution of the natural environment as a significant political issue in the 1972 election year [II-50].

In terms of the market, we have identified an apparent demand by the country's populace for a rather large number of new and rehabilitated dwelling units. We have also seen a number of constraints that are operative in limiting the private, public, and entrepreneural consumer's ability to translate that apparent demand into effective demand (i. e., the number of new houses

for which instructions to build can be given to the industry over a specified period of time) the ability to consummate the act of purchase. Because of this inability in achieving effective demand, and in anticipation of further tightening of money conditions in the future, the National Association of Home Builders (organizational spokesman of the traditional industry) indicates that almost all of its members are scaling down their production operations. Projected reductions on the order of 50 percent in housing starts among its members are not uncommon [II-51].

The Role of Government

The Federal Government does not build housing. It is the role of the Department of Housing and Urban Development (HUD) to assist in the improvement of the means by which the American people are housed and it is the goal of HUD to assure that the country's housing production meets its needs. In broad terms, it is attempting to accomplish both by:

1. Stimulating innovation.

2. Encouraging housing production.

3. Assisting families who need help in obtaining housing.

4. Encouraging state and local governments to overcome constraints upon increased housing production.

Housing Programs. The significance of government to the market can be seen in a single statistic noted by W. R. Smolkin at IBEC: "At least 50 percent of the new shelter market is government assisted." He predicted that "government will be heavily involved in housing in the next decade."

There is growing pressure for the federal government to go beyond its role as stimulator of housing production and to become actively involved in the direct creation of housing, at least as a contractor of last resort. Nonprofit organizations and others actively involved in or concerned with housing are pressing the government for the establishment of a federally chartered and controlled corporation with powers relating to all federally assisted or generated housing. Herbert Franklin, Executive Associate of the National Urban Coalition, has detailed some of those possible powers. They include the following:

1. Right of eminent domain.

2. Overriding of local codes and zoning regulations.

3. Development of land acquisition policy as a function of a federal land bank.

4. The creation of a national land use policy integrated with national housing policy.

5. The use of market aggregation techniques to further national racial integration objectives.

One way of looking at the question of national goals, values, and priorities is by comparing federal expenditures on defense and other areas with that committed to housing, and emphasizing the disparity between money spent for defense, space, and agricultural research with that expended for housing research.

The habit of the Federal Government in using monetary policy to control fluctuations in the economy in a way that immediately and adversely affects the construction industry has often been criticized. Obviously, identifying the markets required for industrialization is of little use if the ability of those markets to create effective demand is strangled every few years by the disappearance of reasonably priced capital.

Another suggestion that moves the question of housing even further into the political arena is to take housing out of the same category as other forms of construction; i.e., to effectively provide housing to low and moderate income people who otherwise could not afford it, loans or subsidies and outright grants should be made directly to them. Many argue that this would eliminate much of the red tape and expense.

In addition, this mode of operation would then permit housing to be built in the most optimal way with the most appropriate setting and at the most reasonable level of integrated community support. It cannot be denied that most government-subsidized programs require housing to be built at a budget level that is so tight as to verge on the unbuildable. The intent is obvious in all of the programs involved: subsidized housing must clearly express its subsidized nature. This approach promises false economies. Housing built in this way cannot but fail to rapidly deteriorate and become part of tomorrow's slum. Simultaneously, the government is committed to maintaining interest subsidy payments for approximately 40 years, a time span long past the

expected point of deterioration. In effect, the government is building like a short-term speculator but committing funds like a long-term investor.

By contrast, many of the countries of northern Europe operate direct-income subsidy programs. Few of their more recent housing projects would be identified as low income housing. As a matter of fact, the populations of such projects reveal variations in income from the lowest to the highest, with only the persons and government agencies directly involved really knowing who is receiving income subsidy. The quality of workmanship and level of amenity and quality evident in those projects generally exceed that in our own developments, regardless of the income level the latter are designed for. Direct-income subsidy is a highly charged political question. A rational approach is not often a politically acceptable solution.

Both the Kaiser and Douglas Commissions bravely put forth rather innovative suggestions regarding contributions to the solutions of the housing question. These two reports to the Congress and President formally state the priorities which the housing problem should receive and have given a degree of credability to the crisis occurring in many cities. The following background of Federal involvement in housing may be helpful.

Traditionally, housing in the United States has been administered by a complex association of private enterprise and public responsibility. Beginning with the U. S. Housing Act of 1937, the programs for government assistance have grown to some 35 in number. Many have specific objectives aimed at economic manipulations including jobs, interest rates, tax base, slum clearance aid to the poor, and other concerns. As a whole, they have not increased the housing stock or effectively provided the "decent home for every American family."

The federal methodology in housing assistance has been a joint application of insurance and subsidy. Programs developed over the years serve three income groups. First are those able to pay their way under a federal mortgage guarantee or insurance program. These programs incorporate the ideal of ownership as part of the American dream and have enjoyed much success, channeling the forces of existing economic institutions into formerly unproductive areas. The other two groups include those just above and below the federal poverty line who qualify for subsidy or assistance. The subsidy programs of public housing date back to the 1937 Act.

Following World War II, a mortgage guarantee program for veterans was widely used in the housing boom that ensued. Generally, it was patterned

after the earlier Federal Housing Administration Program established by the 1934 National Housing Act, but also permitted veterans to borrow 100 percent of the housing purchase cost. The Housing Act of 1949 further increased the Public Housing Program and established a separate slum clearance and Urban Renewal Program, encouraging increased participation of private enterprise.

The 1954 and 1959 acts concentrated on urban problems, requiring a multifaceted workable program for cities to participate. Planning and codes are other obligations that became a part of these programs. Furthermore, nonprofit sponsors were allowed to borrow directly from the government. The Below Market Interest Rate Program has set a precedent for others to follow. In 1965, rent supplements and a leasing program were added. HUD was formulated and later the Model Cities program began. A big step in the evolution of the programs came in the 1968 Housing and Urban Development Act. Directed to low-income groups, it provided for subsidized purchase under the Section 235 Home Ownership Program and for rental assistance under Section 236. These programs relied heavily on private developers and private lenders. Another incentive offered was through the benefits of the National Housing Partnership.

HUD's Operation Breakthrough, an experimental effort to demonstrate through combined programs that innovation is needed, attempts to aggregate markets for industrialized producers. It promises to be no panacea , but does show a degree of flexibility toward innovation. Other government housing programs such as those for the Department of Defense also promise to offer experimentation and industrialization a chance.

Constraints Upon Industrialization — Codes and Labor. Perhaps two of the most severe constraints upon industrialization of housing have been the multiplicity of often conflicting building codes and the traditional intransigence on the part of the building trades towards industrial processes. From presentations and events occurring throughout the country, it seems clear that these two obstacles, while still of momentous import, are being ameliorated at a pace that few in the industry would have expected as little as 5 years ago. Resolution in each case is being achieved through a combination of related events rather than through a single momentous "change of heart."

The problem of codes has been the single most restrictive constraint upon the development of unified market requirements in any one geographical area considered to be large enough to support active industrialized production. Positive developments are those such as California's passage of a uniform code for housing produced in the factory. By this mechanism, once the product is certified by the state agency and in-factory quality control provisions have

approved, that product can be placed on sites throughout the state, regardless of local conflicting code restrictions. Site development remains under local jurisdiction but in California attempts by local authorities to impose further restraint in the form of undue requirements or inspection fees for that portion of the work have been overruled by the State Attorney General. Other states are quickly passing similar legislation.

The second development relating to restrictive codes has been the chartering of quasipublic development corporations, on the COMSAT model, who are actually able to produce housing. Through their state charters, they are empowered to place this housing anywhere in the state, ignoring, if need be, overly restrictive local codes. The Urban Development Corporation of New York is the original and still most effective of these.

It should be noted, however, that work in revising the codes themselves from specification to performance format is proceeding at a much slower pace. This must take place. In turn, it must be supported by a network of nationally recognized testing laboratories, perhaps on the model of the French Agrément. Both must come to pass if innovative, performance-oriented building materials, components, subsystems, and systems are to be developed on a large scale. One effort in this direction has been the development of UDC's Cost-Analogue Testing and Evaluation System, which was described in detail at IBEC.

The resolution of resistance to industrialization by the skilled crafts unions is also occurring in a number of ways. Decreasing membership (and thus a shrinking base of power) as well as the threat of competition from the industrial unions have combined to force the skilled trade organizations to take positive action relating to factory-built construction. Leadership has seen the proverbial handwriting and are active behind the scenes while maintaining a semblance of their traditional public position on industrialization.

Their goal appears to be control-of-the-factory environment by maintaining skilled craftsmen in supervisory positions (at traditional site-labor wages) while accepting unskilled labor and nontraditional job classifications "on the line." The most significant labor agreement thus far has been the Tri-Trades Agreement. This agreement goes quite far in the achievement of those goals.

John Evans of the AFL-CIO made an interesting point that may shed some light on the kind of thinking that allowed the skilled trades to sign a pact such as Tri-Trades. If labor is approached with an experimental program of 1000 or 1500 units in which is suggested new methods that will "cancel out all

the work traditions that we have garnered over all these years of negotiation.... nuts to that noise. But, if you talk to a local trade union about say 1000 units per year for the next 5 years, I think you might reach any desired arrangement including participation by minority workers." Thus, large-scale projects can achieve certain unexpected economies of scale.

There are, of course, a variety of other constraints to industrialization, many of which are shared by the industry at large. They begin to explain the kinds of generalized statistics one often hears concerning the construction industry. The following, offered by John Evans is an example of such a statistic: "In 1955, 4.5 percent of the gross national product was being spent for housing; in 1969, that share had shrunk to 2.5 percent."

It is primarily the building of systems and modules which is represented in the winning Type A submissions of Operation Breakthrough. Thus, while the belief of many that Breakthrough is a systematized process for generating certain results, its stated goal is the development and usage of preconceived housing products — products that can be produced and sold within the existing market now. It is therefore understandable if the results, unlike that of the almost totally late-lamented Type B proposals, are less innovative in terms of life styles designed for housing forms, and material and technology utilized, than they otherwise might be. In that sense, the laudable degree of innovation that is evidenced in the winning solutions is surprising.

Operation Breakthrough. However, the primary contribution of Operation Breakthrough is perhaps the unusual amount of excitement it has generated, and the degree of commitment it has extracted from diverse, previous non-shelter corporations. Many of these companies, already of enormous national scope, have come together in still more powerful consortiums, and those of unusually diverse makeup. Whatever the degree of innovation evidenced in their Operation Breakthrough submission, the size of these companies, their capital generating capabilities, and the political clout they already possess should do much to both unify and restructure the industry. In this and in the diversity of their makeup and management structure as well as in the commitment of winners and losers to stay in the market can be seen the seeds of significant innovation in the entire process of producing the built environment and thereby in the resulting product as well. The entrance and active participation of foreign and domestic building systems producers into the American market may have a salutary effect upon it such as building systems in Europe did to encourage the rationalization of traditional building on that continent.

In still another way, Operation Breakthrough has been innovative; i.e., in the area of marketing. While the separating of all important market

aggregation as a voluntary function tends to inhibit the idea of total control, Operation Breakthrough has had a significant secondary effect upon the marketing of industrially produced housing. That is how it has brought the concept of industrialized housing before the public. Putting aside the insignificant claim that the extent of this publicity may be putting the government once again in the position of promising too much (e. g., what it cannot deliver) and thereby subjecting the entire program to the possibility of mass disillusionment, like that which has befallen other government programs similarly guilty, the ability to dispel the public's negative feelings towards this form of production (feelings which are a hangover from post World War II prefabrication days) is particularly significant.

Housing Production

The complaints lodged against the traditional housing industry for failure to meet the goals and for not accepting innovation readily do not solve the problems simply in themselves. To understand this fragmented industry and to see it as a working system may help to isolate problem areas. An attempt to model it as a system seems to be an orderly approach toward looking for a problem-solving mechanism.

Industrializing the Building Process – Past. The idea of other than on-site construction of shelter, whether it is called prefabrication or industrialized building, is, of course, not new in this country. Its first recorded instance was the "knocked-down" panelized wood house brought by the English to Cape Anne, Massachusetts, in 1624. By 1727, the colonialists were exporting prefabricated houses to the West Indies. These early products were of massive hewn timber frame with mortised and pegged joints, much the same as on-site construction of the time. Pre-twentieth century efforts in this area reached their peak during settlement of the Prairie in the 1870's. Settlers passing through could purchase, or those already "west" could order, from Chicago, completely prefabricated wooden houses packed in boxes especially built to be transported in the massive "prairie schooners" of the day. Each piece in the box was numbered for assembly. Separate boxes contained the chimney in one and the hardware, complete with wrench and screwdriver in another [II-52].

Perhaps more significant than the prairie housing was the earlier effort at production and sale of prebuilt structures to meet the almost overnight need for shelter during the California Gold Rush of 1849. In fact, that activity in manufacturing and merchandising probably should receive some sort of recognition for what might have been the hottest but shortest market on record for any product anywhere. It also holds some marketing lessons for all of us that still, in many instances, have not been learned today.

It seems that the market was so hot that in 1849 over 5000 buildings were shipped around the "Horn" from New York alone. The demand was so great for houses, warehouses, stores, hospitals, and hotels that many structures were not only shipped from other east coast ports, they also came from places as far off as China, Tasmania, and New Zealand. However, before the following year was out, local lumber and brickyards were well underway. In addition, the central California climate of the Sierra foothills made the market literally "hot." Many of the houses shipped were of cast-iron plate, easily demountable for transport and reassembly. Nor only did these dwelling units often fail to go together according to simple plans, much less being thereafter demountable, they were unbearable to be within during that first hot summer [II-53]. One such cast-iron structure, a jail, stands today in a rusty, lonely testimony to past in-glories at one end of a fine version of earlier construction technology, the covered bridge over the Molkolomee River at Knight's Ferry. Unfortunately, at the time, one could not merely call the factory to cancel an order. As a consequence, entire shiploads of mixed cargo, many containing primarily prebuilt buildings, were auctioned off for freight charges alone.

The impact of the industrial revolution found significant expression in terms of assembly of standardized, manufactured parts in Joseph Paxton's Crystal Palace in London's Great Exposition of 1850. It was emulated over the next half century by many of the engineered bridges as well as in the great market and train sheds that still stand as monuments of the "Iron Age of Architecture."

But it remained to the prime movers of the modern architecture revolution movement of the early decades of this century to recognize the need for and, in some cases, actually experiment with (mostly in Europe) the industrialization of housing. To quote but one, in 1930, Le Corbusier and Pierre Jenneret [II-54] wrote:

> "The task is to find and apply new and clear methods, enabling the making of useful dwelling plans, lending themselves for execution in a natural way to standardization, industrialization, and tailorization."

The last term, tailorization, was significant because even then many recognized the inherent dangers that a rigorous hewing to standardization could produce. For that reason, many of those early experiments were construed as the development of a "kit of parts" in the form of interchangeable modifiable structural and enclosure elements so that individual variety between dwelling units could be easily achieved. Unfortunately, none of the experiments

ever got beyond the prototype dwelling or housing development stage. However, we will see the "kit of parts" idea later. By the late 1930's and then through the impetus of increased shelter demands during the war years of the 1940's, the idea of prepackaged houses, generally of panelized construction, did find a certain market. From this activity, which came to be known as prefabrication stemmed, as we shall see, many of the practices as well as many more of the problems that industrialized building must today answer to.

More significant at this point in our discussion, particularly in terms of reasons that have been suggested for their failure, were some of the well-known products of the post World War II era. The Lustron House was a fine house by almost all standards. Its manufacturer recognized early the problem of overproduction for existing markets of at least some of its unique components. Thus, while production of Lustron House was envisioned at 40 000 per year, the Lustron bathtub stamping machine could produce one complete tub shell every few seconds. The machine's cost break-even point was approximately 120 000 tubs per year. The obvious answer and intent was to develop a lucrative secondary source of income by marketing the oversupply. The only problem was that the Lustron tub was 61.5 inches long. This is in conflict with what was then, and is now, one of the very few dimensional standards, 60 inches, by the very industry, traditional homebuilding, that was to absorb that oversupply. The hoped-for market failed to appear [II-55].

The Alside home was an elegant steel-framed product with sandwich panels of colored aluminum on the exterior and hardwood paneling on the interior. Its interior accutrements such as kitchen cabinets, appliances, and amenities were such as had previously appeared only in customed-designed residences. No wonder, then, that all the industry was excited, and some trembled at the thought of all this coming on the market for the promised price of approximately $20 000 f. o. b. the factory, but Alside failed. Some say that the mass consumer was not ready for its contemporary design. A more significant, or at least more definitive reason, lay in the fact that the announced price climbed astronomically, as delays, production problems, and the requirement to amortize a $2-million plant occurred in the actual manufacture of first models.

The Normac House by Northrop Corporation was one of the few precast concrete panel houses of that period. Its dimensionally coordinated panels were few in number and could be relatively easily varied in production. Even at that early date, the panels were of lightweight concrete. Its assembly line technology was as advanced as the most advanced "heavy panel" (concrete) systems in production in Europe today. But management was apparently used

to the concept of relatively sustained markets for manufactured products and therefore was (at least in part) tripped up by the unique volatile, conflicting, and often short-term characteristics of the building markets. It also became obvious that the manufacturer, working on normally lower margins of profit than the builder or developer, was more susceptible to the fluctuations and vaguaries of that market. At that time, the builder or developer also pyramid his profits by appreciation in land values, control of consumer financing, and tax advantages. Also, by appreciably shortening construction time, the manufacturer materially increased the builder's profit by allowing his shorter time requirements for high-cost interim (construction) money and by earlier income productng, move-in dates, all at no appreciable additional profit to the manufacturer himself [II-56]. Almost 4000 Normac houses were produced before production ceased.

Spotty Record For Industrialization and Innovation. Actually, all of the named examples and many others as well suffered from these last-described difficulties. At that time, the direct costs of on-site construction had not yet risen to anywhere near the lofty levels at which they are now. Thus, truly significant savings in low-cost factory labor, buying power, and other advantages of industrialized production had to be found to offset the cost of plant and transportation of the product. The latter problems were compounded by the fact that at the time almost all American attempts at the factory production of housing were concentrated on the single-family house. Thus, by definition, for a given project at a given location, or even within a specified radius of the factory, there were fewer units involved than there are today in current systems of conventionally-built, high-density multifamily projects. Finally, production innovations such as simplified, highly mobile on-site plants had not yet been developed nor had financial innovations such as the amortization of a majority of plant and equipment over the life of a single large project been considered.

In the past, at least, innovations in construction technology in the United States have come in the area of individual materials and components, with far less efforts in the area of complete dwelling construction techniques. The primary reasons are similar to others we have seen; high costs and risks of innovation combined with a relatively low potential for payoff [II-57]. These conditions have been severely aggravated by the fragmented nature of the market and the resulting fragmentation of supply into a large number of small producers incapable of (and not stimulated to) significant R&D efforts. (The top housing producer in volume last year, Levitt and Sons, actually had less than 1 percent of the total housing market [II-58].) The building industry remains the most fragmented large industrial complex in the nation today [II-59], but the picture is changing rapidly. Recently (prior to, as a part of,

and even since Operation Breakthrough), large American industries have shown a willing eagerness to become involved with the production of housing, even low-income housing, if conditions seem to promise reasonable profit. These industries have acted both singly and in consortium with other equally large, as well as smaller, firms.

Involvement in Housing by Members of Nonshelter Organizations. Initial efforts by these companies, most of whom were previously outside of the conventional shelter industry, met with some unfortunate and, in a few cases, disastrous results. Once again, the constraints and volatile nature of the market and its many factors produced for their stockholders some unexpected results for these companies and some unhappy news relating to these ventures (General Electric was one, Westinghouse another). A period of reaction set in during which time many of these large industrial corporations stepped back and out of the market to review their actions while at the same time becoming better acquainted with that market. Re-entrance by some of these companies, as well as by many new ones, began anew a short time later, segment of the general "conglomeration/merger mania." These entrances into the market generally took the form of merger with or acquisition of large successful shelter-producing firms, both old and new, but always proven in their ability to function within the market. Mergers of this kind were marriages of convenience. The outside firm acquired additional return of revenue from a source diversified from their main stream of activity while the housing producer acquired the backing of large capital resources vitally necessary to expand operations beyond local markets and to provide the capital required to buy and hold large acreages of land necessary for that expansion. In these cases, neither management personnel nor procedures were significantly changed on the part of the shelter-producing firm; therefore, industrialization of the production of housing was not, at least, a direct goal. Typical of such mergers were ITT - Levitt, Inland-Steel - Don Scholz (the latter was, however, already a leading producer of factory produced modulars), and Penn Central - Great Southwest-Macco.

More recently, new entrants, both industrial and consortium, have entered the housing market with the expressed intention of bringing industrial management and production expertise to the process itself. Some would even go so far as agreeing with Simon Ramo of TRW that "Civil Systems" (TRW's term for solving environmental problems, including forms of shelter) is the next great market for American industry. Ramo believes, in fact, that the market will be so large that its actual dimensions are as yet unfathomable. At the least, he believes that a new social-industrial complex will develop that will dwarf in scope and size that much alluded to military-industrial complex.

Organization and Management. Perhaps that most frequently alluded-to innovation in the construction industry in terms of facilitating widespread applications of industrailized techniques is the "revolution" in management. It is difficult to define revolution in explicit terms. Forces for organizational and management change have occurred within industry by those firms who have shared the previously delineated "realizations." They have also come from without, mostly by nonshelter corporations looking to get into the industry. The latter occurred in almost a cyclical way that can be viewed in three stages.

The first stage occurred in the late 1950's and early 1960's when firms such as General Electric, Westinghouse, as well as a host of lesser firms "barged right in" without a real understanding of the market. They did not appreciate the differences between the consumer goods market and that which encompasses real estate, land development, and the production of the built environment. Many came with the full intent of bringing the full fruits of technological capitalism to that "industry." What they found could scarcely be called an industry in the terms they were familiar with. They were astounded, confounded and often "burnt" by this nonindustry. This nonindustry was characterized by an inability to generate financing, was tied to cyclical economic forces beyond its control, and was saddled by a bewildering, delay-making array of conflicting local codes, regulations, and trade agreements. The sponsor firms quickly withdrew to "lick their wounds." They also studied that "market" with a more wary eye.

Apparently, what the sponsor firms learned was to stick with the "tired and true" and to tie up with the "winners." Thus, the second cycle saw most of the major (successful) conventional independent housing producers joint-venturing, or, more often, merging or being purchased by large, national, and generally nonshelter corporations. As mentioned above, these were largely mergers of mutual convenience. This second cycle hit its peak in the second half of the last decade and continues at a slower pace.

However, it is the third and newest stage of this continuing development that one must look to for significant types of organizational and management changes. Reconfigurations of the industry itself appear to be involved. These reconfigurations are producing and will continue to produce significant technological innovation. "Systems building" is a term which typifies the third stage. The significant aspect of systems building is that it is process oriented. It involves the assembly of a multidisciplinary team that begins at the very beginning with the determination of user needs. It then proceeds through a full-cycle systems approach, including performance design, synthesis of alternative solutions, analysis of the alternate solutions synthesized, selection of

the optimal solution, prototypical development of that solution, production, installation performance evaluation, and feedback to inform and correct the process.

What many of us feel to be the highest level of this new stage is not actually new. Systems building could be said to have had its genesis in the post World War II development of English Schools Construction Systems, such as CLASP. It was thereafter brought to high degree of development in the NENK system for domestic military construction in England, the MARBURG University System in West Germany, and, in a slightly different way, in Marcel Lod's French System. This last system was designed for a variety of uses but has found its initial use in a large multiple housing project near Rouen.

This process can be initiated by a public body, a professional or group of professionals, or by some other individual or organization within or outside the traditional industry. It depends for its initiation upon the discovery of a large-enough client to underwrite the cost of the development process, or as has been more often the case, upon the aggregation of many similar clients to create that capability. The client then, in turn, becomes a market large enough to consume the initial production runs to a degree sufficient to amortize development costs of the actual production process. As is often the case, this will attract manufacturers who will be willing to tailor the production of products, subcomponents, etc. to the requisite performance standards.

The resulting product of that process may or may not be an industrially-produced building system. If this is true, it is as a result of the total requirements of the problem. As such, the building system that results is tailored for a specific group of users and has limited applicability for totally different purposes. However, within the needs of the specific user group, it can have as much capability for flexibility, growth, and change as the total context of the original problem dictates. It is to this kind of process thinking that the development of the American SCSD and URBS systems and the Canadian SEF and RAS systems owes their original genesis. But much of the innovative thinking and development was required to make that process operable in North America.

The second level of this stage, on the other hand, can be seen as definitely product-oriented. Building systems are not new, having been in production in eastern and western Europe for over 15 years. Post-war Europe, faced with intense shortages of resources, skilled labor, and an immense need for immediate replacement and new housing, had little choice but to rebuild a major portion of its shattered housing industry along industrial lines. The primary form of technology involved, factory-cast heavy concrete panels

and slabs, is even older than the basic approach itself. Building systems were initiated in Europe primarily by existing, large-scale building organizations. Most often they were general contractors, but in some instances they were concrete fabricators or other types of structural fabricators. Many of them continue today to operate conventional construction systems in parallel with their building systems operations.

Building systems are most often characterized by the structural type, but they can also be classified by overall generic use; e.g., schools, multiple or single-family housing, commercial office, etc. However, unlike systems building, within each generic type they are designed not for a specific user or group of users but for a maximum variety of such users. Therefore, within the basic (and usually significant) constraints of structure, they attempt to offer maximum variability in certain design and planning elements. Some European concrete systems offer a modicum of facade and individual unit layout variation. Most, however, are extremely limited in their flexibility of design and amenity. The site layout of some of the housing developments that utilize these building systems have been accused of being designed by optimal (tower) crane rail layout; e.g., in absolutely straight lines. European building systems producers, in some instances, initiate projects while in other situations, they will compete for them from local housing authorities or non-profit sponsors.

Systems building and building systems have some similarities beyond that of their names. Most significant is the concept of total control. Quite often, project initiation and almost always design, production, and erection occur under one roof. In this way, construction industry manufacturers become active producers rather than merely suppliers. In so doing, their ability to control costs and their responsibility grows to include the entire operation and often extends to operation or management of the completed project itself.

The most advanced and sophisticated management methodology is utilized, including CPM and its construction counterpart, "fast tracking." Proprietary systems in European countries rarely if ever stack or store building parts, components or subsystems anywhere out on the site. Structural panels arrive on specially built transport from the factory and pull up under the tower crane just as a 4-man erection crew was completing the installation of the previously hoisted panel. The 4-minute erection time per panel was amazingly consistent between projects and countries without any noticeable queing of transport. Pre-planning is in evidence.

The third and final level of this most current stage can be seen in the rapid proliferation of "module builders" in this country. The current generation of "modules" by and large can scarcely be called building systems. In many instances, traditional construction techniques and materials have moved into the shelter of a factory of the most modest kind and put on rather crude forms of assembly lines. This has allowed producers to gain certain advantages in the use of lower-skilled factory labor (under the watchful eyes of traditionally skilled site craftsmen) economies of scale in materials purchase and year-round weather protection. For these advantages, the current generation of mobile producers must accept design constraints imposed by the fixed three-dimensional envelope of the "box" and the limitations imposed on that box by transportation requirements. Some of the module manufacturers are presently producing only for their own consumption while others are planning to develop a nationwide network of franchises or dealerships along the lines of mobile homes manufacturers.

In fact, technological innovation in module design and production is often of the type and at the level of mobile home production. That is now always a positive attribute. While mobile home production in this country has been up to now the most complete example of factory-produced shelter, it has been able to develop in this way because mobile homes, as personal rather than real property, have been subject to vehicle code regulations and not to the diverse, often restrictive dictates of local housing and building codes. As a consequence, mobile home production has often been characterized by shoddy construction.

The industry itself is rather sensitive to this situation. In fact, some of those producers who are mobile-home-manufacturers-turned-module-builders explicitly state in their module advertising that " this is not mobile home construction but rather construction of fixed, on-site quality."

This situation is being partially ameliorated by the industrialized housing codes recently enacted in California and other states. Under this code, module and other forms of factory-produced housing will be inspected in the factory and, when passed, will be certified for use anywhere in the state, thereby superseding the deleterious effect of conflicting local codes.

However, the state codes only in the most indirect way control the quality of construction; i.e., in terms of health and safety as reflected in structural, sanitary, fire, and exit/egress requirements.

In Europe, building systems producers, in an effort to replace the client's independent consultants, such as architects and engineers, and thereby achieve the desired "total control," are offering as incentives, unified

guarantees of extended duration, often even into on-going maintenance contracts. It is therefore unclear how module producers in this country are proposing to provide guarantees of quality and durability to the developers who buy the product "off the shelf" or, more importantly, to the final purchaser and occupant.

Conclusions - Summary

Historical hindsight points to successes and failures. Sometimes it guides future decisions. The facts related to events in time are usually many faceted. We do not always see their influences adequately. Generally speaking, the causal events of this century have so rapidly followed one another that historical analysis of effect has been lagging in its feedback effort to guide the decisionmakers. The use of technologically advanced machinery and methodology for purposes of data gathering and analysis offers some hope for closing the time gap.

The buildings that a culture erects are in themselves a physically measurable and deterministic factor in the structure of civilization. Since these elements are known, their design and purpose in society can be helpful in forming viable conclusions and recommendations. To be able to see and to gain visability toward the meaning of our physical surroundings holds much promise for a successful future.

REFERENCES

II-1. Reps, John W.: The Building of Urban American A History of City Planning in the United States Princeton University Press, Princeton, New Jersey, 1965.

II-2. Scully, Vincent: American Architecture and Urbanism. Federick A. Praeger, New York, 1969.

II-3. Clark, Kenneth: Civilization. Harper and Row, New York, 1970.

II-4. Douglas, Paul A., Chairman: Report of the National Commission of Urban Problems to the Congress and the President of the United States. Building the American City, The Douglas Commission Report, House Document No. 91-34, The 91st Session of Congress, December 12, 1968.

II-5. Kaiser, Edgar F., Chairman: Report of the President's Committee of Urban Housing. A Decent Home, The Kaiser Commission Report, U. S. Government Printing Office, 1969.

II-6. Time: Housing, the Swing Back to "Ticky-Tack." August 19, 1970.

II-7. Close-up: A New Model in Housing. An interview with Harold Finger, Assistant Secretary for Research and Development, HUD, DUN's.

II-8. McQuade, Walter: An Assembly-Line Answer to the Housing Crisis. Fortune, May 1, 1969.

II-9. Mayer, Lawrence A.: The Housing Shortage Goes Critical. Fortune, December, 1969.

II-10. Ibid., p. 138.

II-11. McQuade, op. cit.

II-12. Douglas, op. cit., p. 66.

II-13. Mayer, op. cit., p. 86.

II-14. Close-up: A New Model in Housing. op. cit.

II-15. Smith, Wallace F.: Housing, The Social and Economic Elements. University of California Press, Berkeley, California, 1970.

II-16. Holzbog, Thomas J.: Prifaba, Past Present and Perspective. Construction Products and Technology, June 1969.

II-17. Iredale, Ralph: Building Systems an Approach to Organized Building Processes. Paper presented at the annual meeting of the American Society of Civil Engineers, September 30 - October 9, 1968.

II-18. House and Home: Clearing the Air-About the Cost of Housing to People Who Can Afford It/About the Cost of Housing for the People Who Can't Affort It. Editorial, September, 1970.

II-19. Mayer, op. cit., p. 88.

II-20. Ibid., p. 87.

II-21. Ibid., p. 89.

II-22. Ibid., p. 88.

II-23. Ibid., p. 89.

II-24. Outlook: Building Blocks for Profit, Modular Housing. Birth of An Industry.

II-25. Mayer, op. cit., p. 89.

II-26. Time: Housing. November 15, 1968.

II-27. Production: Part IV, the Housing Enigma. June 1970.

II-28. Kaiser, op. cit., p. 8.

II-29. Mayer, op. cit., p. 138.

II-30. Kaiser, op. cit., p. 7.

II-31. McQuade, op. cit., p. 99.

REFERENCES (Continued)

II-32. Mayer, op. cit., p. 88.

II-33. McQuade, op. cit., p. 99.

II-34. Housing, The Swing Back to "Ticky-Tack." op. cit., p. 56.

II-35. Ibid.

II-36. Closeup. op. cit.

II-37. Mayer, op. cit., p. 88.

II-38. Ibid.

II-39. Reukema, John J.: California Faces a Housing Crisis of Grave Proportions. American Journal of Building Design, August, 1970.

II-40. Mayer, op. cit., p. 68.

II-41. Ibid.

II-42. Ibid., p. 88.

II-43. Housing, The Swing Back to Ticky-Tack, op. cit., p. 56.

II-44. Clearing the Air, op. cit.

II-45. Ibid.

II-46. An Open Letter, op. cit.

II-47. Clearing the Air, op. cit.

II-48. Holzbog, op. cit., p. 33.

II-49. Ibid., p. 31.

II-50. Mayer, op. cit., p. 86.

REFERENCES (Concluded)

II-51. Roberts, John: Home Building U.S.A., A Systems Analysis Industrialization Forum. Vol. I, No. 3, April 1970.

II-52. Peterson, Charles E.: Pre-fabs an Old Technique, Architectural and Engineering News. June 1967.

II-53. Ibid.

II-54. Bender, Richard: Selected Technological Aspects of the American Building Industry. Prepared for the National Commission on Urban Problems and Distributed by the Clearing House for Federal Scientific and Technical Information, Springfield, Virginia, January 1969.

II-55. Koch, Carl: Component Design for the Urban Environment. Building Research, January - March 1968.

II-56. Brownlie, J. A.: President's Report to Normac Inc. Stockholders, June 10, 1952.

II-57. HUD, Phase I In-Cities Experimental Housing Section II.

II-58. Ibid.

II-59. Systems Building. Engineering New Record, October 30, 1969.

CHAPTER III.

DIAGRAMMATIC PRESENTATION OF PROBLEM

CHAPTER III. DIAGRAMMATIC PRESENTATION OF PROBLEM

Introduction

Sensing Housing as "A System-as-a-Whole." The Auburn Design Group quickly realized that they were viewing an exceedingly complex phenomenon. However, they also soon began to sense that it was an entity which tended to have certain qualities and operate in certain ways. Together, these specicalized characteristics appeared to comprise an existing operating system. For this special kind of phenomenon, the term "a system-as-a-whole" was adopted. To qualify as an identifiable system-as-a-whole, at least two requirements should be met:

1. Specific functional elements had to be defined.

2. Functional interrelationships between these elements had to be identified.

If these elements and their interrelationships in combination created new characteristics not separately attributable to either of them, these special characteristics were termed "holistic" qualities of the system. This concept can be perhaps best likened to the popular dictum, "the sum is greater than its parts."

A Systems View of an Existing Phenomenon. Having sensed the existence of a complex system, an initial graphical representation of that system was developed. Figure III-1 could be a picture of any system as a whole. Basic system concepts (Fig. III-1) can be seen in abstract terms that were used throughout the summer program. It is, first of all, a two-dimensional representation of an n-dimensional problem space. Contrary to what the diagram might suggest, it is not a static system. This system should be viewed as a constellation of elements which are constantly changing position relative to each other. In addition, this entire constellation (called the housing system) is moving through space over time. That space is the greater system environment.

The systems environment contains the universe of things of interest which relate to the subject of housing. The housing system can then be seen to be embodied within its greater environment. The system's functional elements can be seen within its interior space. These elements were considered to be the operational resources of the system; i.e., these are the

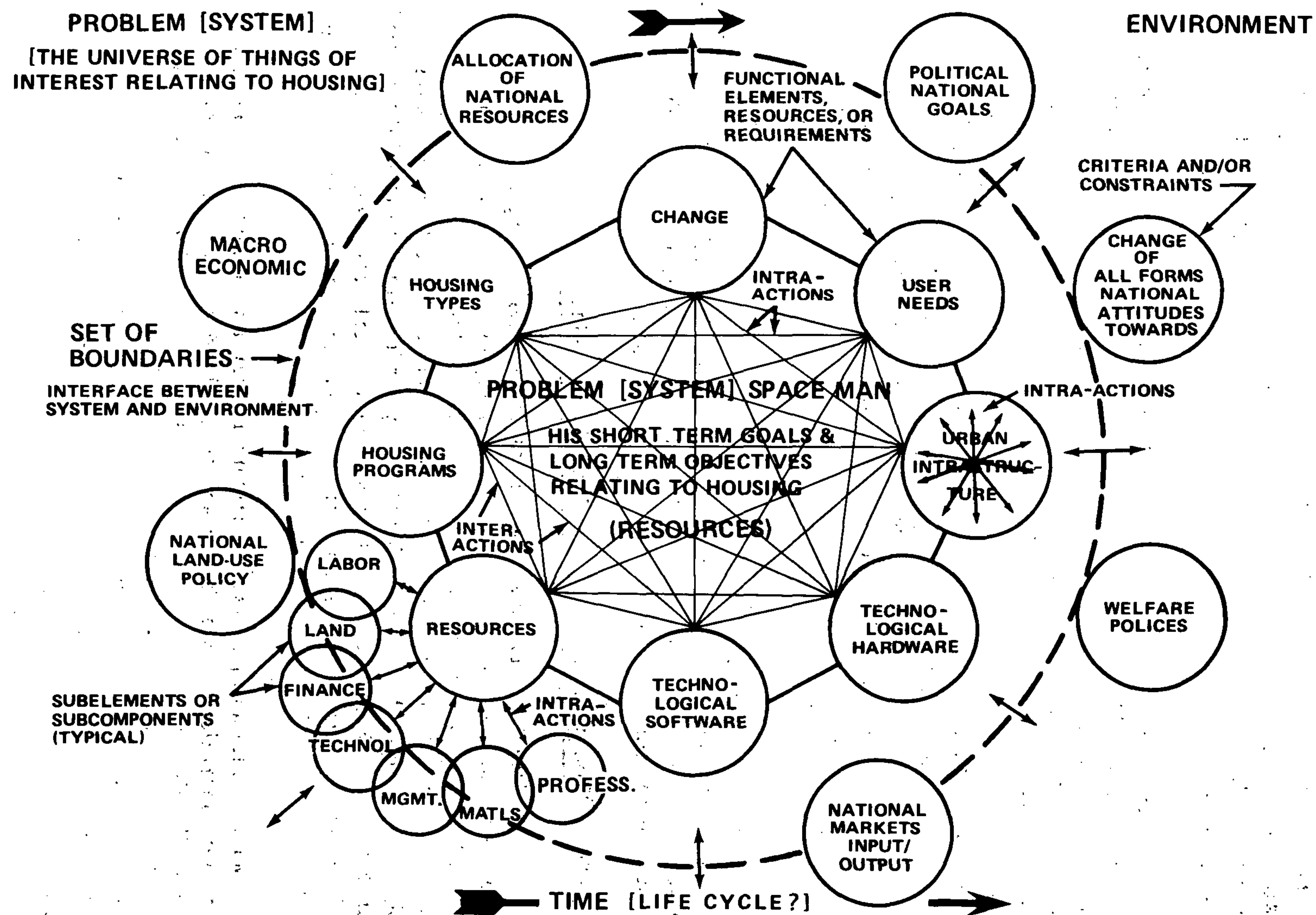


Figure III-1. Housing as a man-centered encountered system — a first cut.

elements over which the system has control and which it uses to work and seek after its objectives. If the term problem-space synonymous with system space is used, these elements can alsc be considered requirements for problem definition and solution.

The lines between each element within the system indicate the functional interactions. In addition, to carry the concept of embedment further, each element can be considered a subsystem containing subelements with their special interrelationships. These relationships within the system's individual elements are termed intra-actions.

Outside of the housing systems space are things of interest which affect and are effected by the operation of the system but over which the system has no control. In an abstract sense, these are termed "environmental givens." However, they can be understood to be both criteria which define how the system's objective or objectives must be met and as constraints which limit operational modes of the system.

In viewing the housing problem as a system in this manner, it became clear that stating specific objectives would be a way of establishing the boundary of the system. In turn, it would determine the constituent parts with which to work and those which would have to be accepted as given.

Why a "Decisionmaking Mechanism" for Housing.

Selecting the Objective. Even though the housing process could be viewed as a complex system-as-a-whole, the task of identifying the objectives of that existing system as well as the functional elements and interactions working in support of those objectives were found to be only slightly less difficult. It was realized that the dynamic nature of the man-centered system depicted in Figure III-1 could have no clear-cut universally agreed-upon objective. As was discovered in the information search, each participant in the system tended to state his objectives differently.

With this kind of problem environment, the task of stating a specific objective or operational problem statement for the summer program was found equally difficult. It was not achieved in a day or in a week. It did not occur within a month. Identifying the objective of an existing social system and stating objectives for problem solving relating to that system turned out to be infinitely more difficult than it might have been for a typical physical system.

What evolved in the latter stages of information gathering could be called an iterative process. A series of potential design program objectives was posed which in turn provided directional probes for reentry into the literature.

Three alternative objectives made up the final iteration of the objective-definition cycle. These objectives included a variable alternatives living unit-new-town design and a decisionmaking mechanism for housing. Note that each is a segment, on a different scale, of the greater housing process. In fact, each could be considered to be embedded in the next increasing level in the hierachical order in which they were just listed. In effect, selecting the object would be establishing the boundary for the group study. Each of these alternative objectives held special interest for particular members of the group based upon their own background and upon new knowledge which they had gained. However, two perceptible trends began to develop toward the end of the information gathering phase which in the end resulted in the choice, a decisionmaking mechanism.

Reasons for the Decisionmaking Mechanism. It was found that specialized reports within the literature of housing produced by one or another of its functional actors rather consistently saw the problem primarily through that participant's eyes alone. This was true whether the authorship stemmed from the traditional construction industry, its industrialized component, the labor element, the financial community, etc. Each seemed to feel that the national goal for housing production could actually be met by conducting business as usual — if! That "if" usually meant if only certain criteria could be revised or constraints relaxed which impinged upon what they construed as their own most effective operation. The source of the offending criteria and constraints was almost always attributed to some other element in the housing process. In other words, it was most often "the other guy's fault."

Conversely, generalized overviews in the literature of housing attempted to be both so broad and impartial that they could do little more than but mention significant problem areas, much less delineate such problems in any useful depth.

The second development had to do with the many speakers who came to talk to the group. Their presentations were found to be a rapid, useful method for the development of our state-of-the-art knowledge of the problem and process of housing. However, each was a recognized expert in a specific

area of housing with much knowledge about and experience in that particular area. Consequently, each speaker once again tended to view the entire housing situation through a very narrow and select set of filters. As a result, each speaker invariably recommended that the Auburn Design Group address itself to a specific objective within his narrow area of interest. The result, stated or implied, would be that the group would somehow be getting to the greater problem that is the entire housing process.

These attitudes were found to be useful and understandable, and yet it became clear that no one seemed willing to take a holistic comprehensive yet-detailed view of the housing process as a "systems-as-a-whole."

Ascertaining an Unmet Need — Key to Stating an Objective for Systems Study. The group began to perceive the existance of an unmet need related to the social system which was being examined. However complex with difficulty meeting that need might be, it clearly required at least an attempt at fulfilling. The identification of an unmet need is the primary prerequisite to stating a coherent, socially useful objective for a systems study for a man-centered problem.

Delineating the Need. If this need could be met, the various actors within the housing system might be better able to evaluate alternative courses of actions open to them in light of their own objectives. An understanding of the operations of the larger system within which they operated could only encourage realization of this possibility. Those outside of the system (i.e., within its environment and therefore affecting or being effected by its operations) could also be served by meeting this need, because they would then have the opportunity to evaluate the various, often conflicting alternative actions open to the system with a view towards understanding the implications of each, and that prior to the course of action actually being taken. For example, if Congress pontificates upon the housing problem and the need for new legislation, and even passes new legislation — or if having passed it, fails to fund it — or if funded, the administration fails to actively allocate or release these funds, not only will each actor understand the full implications of his actions, each will know beforehand that the voting public will be privy to the same information and will therefore understand as well.

Once this unmet need was clearly enough perceived by the Auburn Design Group, its configuration into a specific objective for the program's summer effort was easily accomplished — an attempt to at least begin the development of a decisionmaking mechanism for housing.

The group was aware from the beginning that the particular collection of expertise represented in this program could hardly do more than to begin addressing any of the three alternative objectives, particularly within the constraints of the time available. Nonetheless, the group felt that the objective selected and at the scale indicated promised the most effective use of resources available to the program.

An Operational Organization for Problem Solving — Selecting a Generating System. Once the group was able to clearly state its program objective, it immediately became clear that Figure III-1 could be of no additional help. It had helped to identify and understand the existing system as a whole; i.e., the housing process. But, once having that objective this diagram could not assist in usefully extracting and working with specific functional elements or requirements, inter- and intra-actions between those elements or the constraints and criteria under which they must operate, all within the context of the new problem as specifically stated. The functional element titles indicated merely showed topics which reoccurred in the literature.

The group was about to move into a new phase which required a new operational mechanism — a particular systems approach to problem solving. This approach was called a generating system. This would have to be a methodology which would allow both fruitful attack of the problem and the provision of a process by which that attack by 20 different individuals could be effectively managed. Only through the adoption and successful operation of this mechanism could it be hoped to delineate the problem clearly enough to reach the third and final stage of the systems design experience — the design of a solution that could operate upon the existing system within the context of the objective or, alternatively, could pose new forms of the system better able to achieve the stated objective.

Objective - Inoperational Terms

The generating system selected for use took the format shown in Figure III-2. It may be recalled that a similar format was used to introduce the design program in a previous chapter of this report. In the context of a problem-solving mechanism, it can be seen that the various systems components identified earlier have now been restructured into a more operationally useful way.

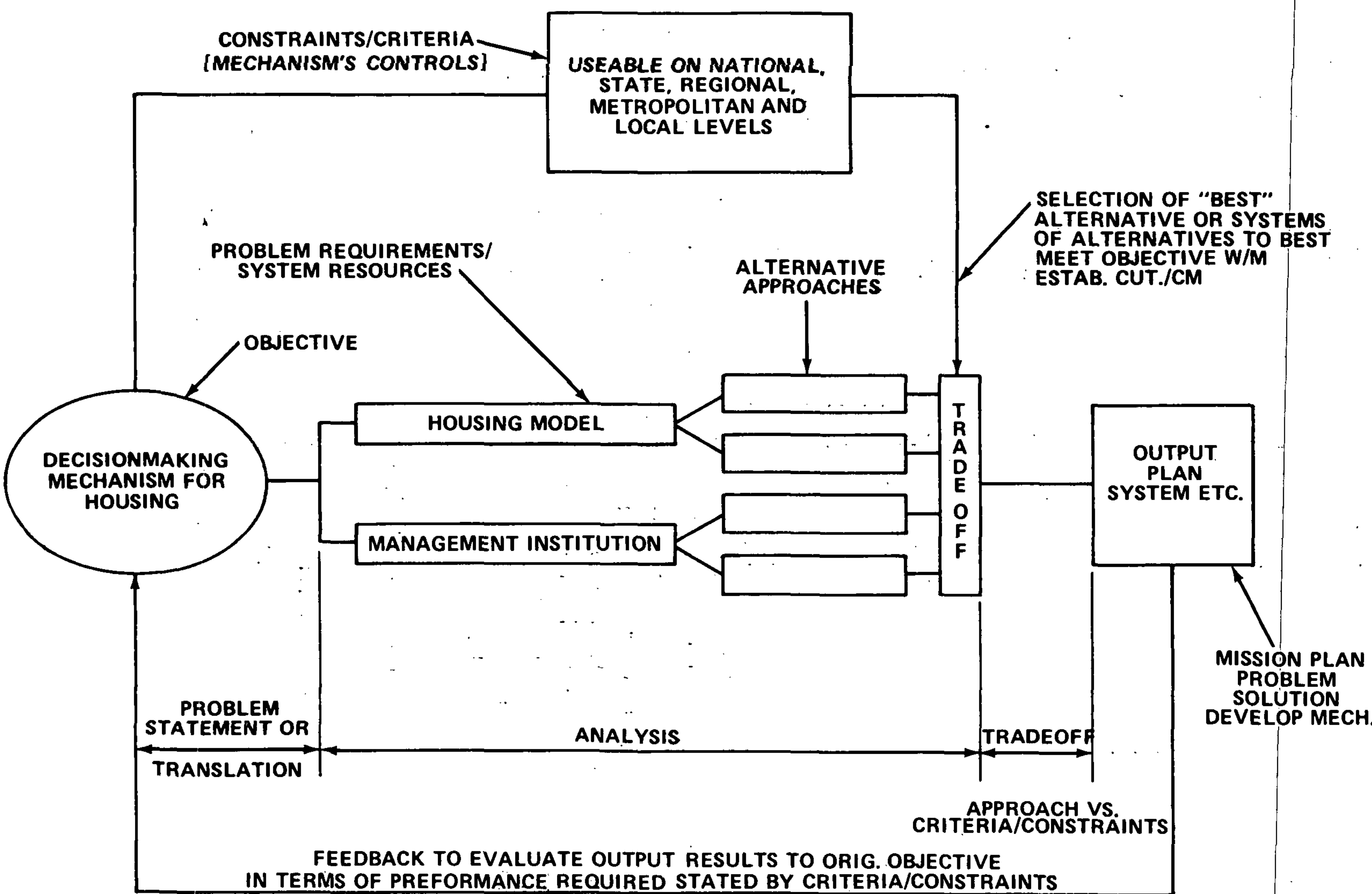


Figure III-2. Decision-making mechanism for housing.

The overall group objective, a decisionmaking mechanism for housing, is stated within the ellipse at the far left of Figure III-2. This is the definitional translation of the objective into a problem statement. This, in turn, feeds forward to a breakdown of previously discussed systems components. The boxes in the middle of the figure are the system's requirements or resources, those elements over which it has control and with which it performs work on the system. For the problem objective, two main requirements were identified — a model of the housing process and a management institution to operate the model. Immediately above are listed the other problem solving components which evolved from the problem statement. These are the criteria and constraints impinging upon the problem space from the greater environment. They can also be called the mechanism's controls. They serve to identify the conditions under which the problem statement must function to be operational. A single element which can be construed both as a criteria and a constraint is that the decisionmaking mechanism must be usable on a national, state, regional, metropolitan, and local level.

This single element can be further expanded, although it is not shown in Figure III-2. A constraint upon the objective is the very nature of the diverse, widely diffused decisionmaking process which is a major holistic property of the existing system. Criteria are that which is within the present system of free enterprise and business/government quasipartnership. This mechanism must be a voluntary one. If it is to be used, it must show clear advantage for its use to all participants in the housing process, and then in terms of their specific objectives. Obviously, these objectives vary for each. The mechanism must also be extremely flexible. These considerations shall permeate the remainder of this chapter.

The requirements, in turn, feed into the vertical series of boxes to their immediate right. These are indicative of possible alternative approaches to satisfying the requirements. The alternatives, together with the requirements,comprise the analytical phase of this approach. The alternative approach boxes feed into a box immediately to their right which are labeled "tradeoffs;" i.e., where each alternative is considered in terms of its ability to meet the original objective. It should be noted that the constraints and criteria feed into this box. This is a graphical indication of the fact that this consideration of various alternative approaches is at all times conditioned by the previously established constraints. Because of this operational mode in all liklihood, no single alternative alone will be able to fulfill the needs of the original objective. Hence,the name of the box is a definition of its functional operation: the synthesis of an alternative or finite set of alternatives which has been

brought about through trading off advantages and disadvantages of the previous series of approaches to best meet the stated constraints and criteria. The result is the final box at the extreme right of Figure III-2. It is the output or solution which would be hypothetically synthesized which is believed at this stage to best meet the original objective. This can be in the form of a stated mission, an operational plan, a system made up of a kit-of-parts (i.e., specific elements and stated rules which control their permissable interactions), a broadly stated problem solution, or a carefully developed and designed mechanism. In the case of a specific objective, it is possible to jump ahead and state the desired output in the following operational terms:

- A rational methodology for making decisions relative to achieving the broad national goal.

- A decent home and suitable living environment for every American family.

The kind of decisions produced would possibly involve the following factors:

1. The number of units of housing required, desired, and/or producible under a given set of conditions. These conditions would appear as inputs into the decisionmaking mechanism.

2. The use of land, allocation of natural resources, the structure of and requirements for financing, and the necessary public services such as utilities, transportation, health, education, and welfare as implied by that set of inputs.

It should be remembered, at this stage, that any final output is not necessarily the desired end item. As the feedback line implies, this is an iterative process. Each output must be fed back through each successive stage, considering its abilities to meet the originally stated objective in light of the stated criteria and constraints. It might be found that it is able to very closely approximate the originally stated objective on the very first cycle. On the other hand, it may be necessary to return to the analysis stage in order to pose new alternatives and thereby allow additional tradeoffs to take place. By failing, it may be necessary to cycle further back to create additional requirements. If this fails to eventually produce acceptable output, it may be necessary to return to the beginning of the problem and even restate the original objective itself.

Now making the concept of systems embedment operative will be illustrated (Fig. III-3). Each of the two requirements become the objectives for new submechanisms. These submechanisms are then expanded into their own set of requirements and constraints. The housing model will be considered first.

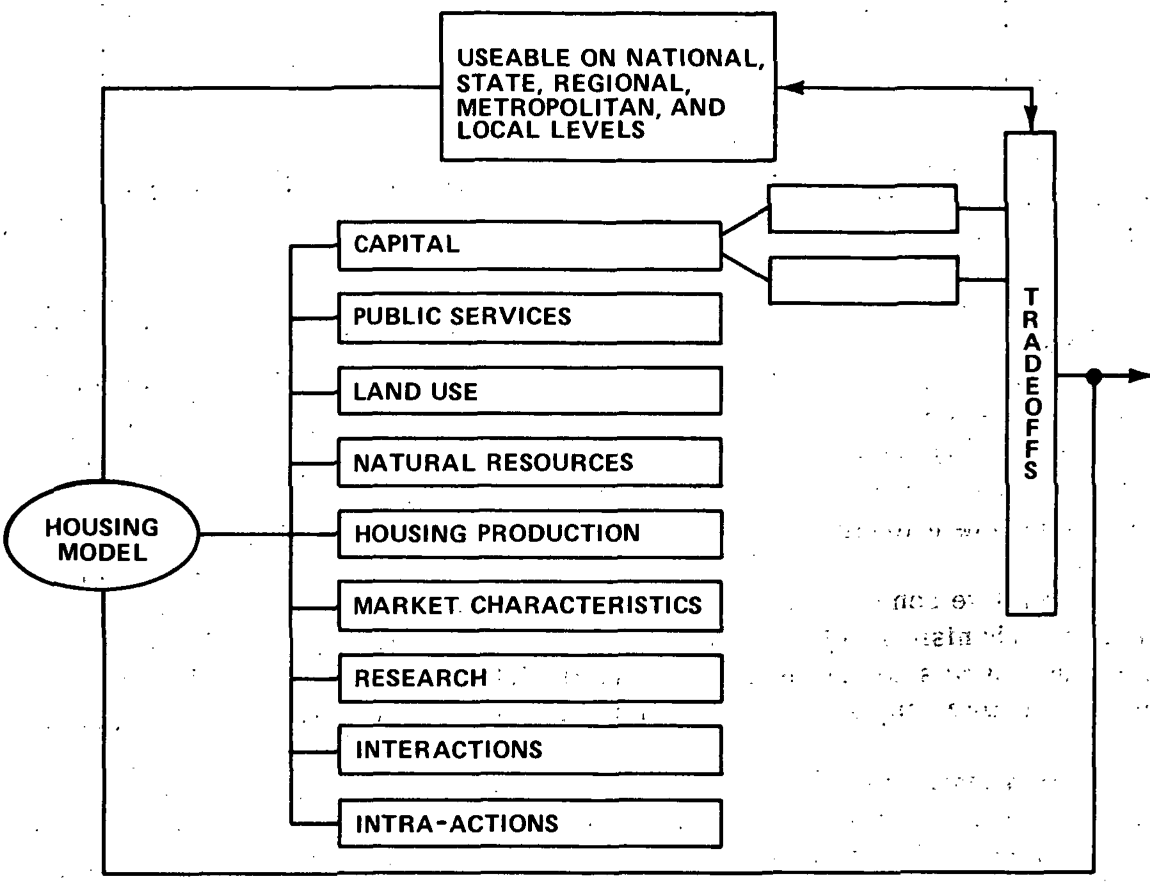


Figure III-3. Housing model.

Housing Model

Output. Decisions pertaining to land use, allocation of resources, financing, and public services in providing housing needs.

Constraints. Decisions must be usable on national, state, regional, metropolitan, and local levels.

Requirements.

1. Capital.
2. Public services.
3. Land use.
4. Natural resources.
5. Housing production.
6. Market characteristics.
7. Research.

The housing model (Fig. III-3) has now become an objective and it is the opinion of the group that this is the heart of the problem. The constraints at this level remain as for the overall objective.

In establishing the requirements within this format, it was discovered that certain elements did not quite fit the semantic level of the other individual requirements. Rather, they seemed to be infused within all of the requirements of this submechanism and to somehow tie them together into a meaningful whole. It was determined that these are the intra-actions that exist within a specific major functional component of a system that serves to tie the subelements of that component together.

In a like sense it was discovered that other elements did not fit to this submechanism's objective but were somehow related to its definition and operation. It was determined that these are interactions between this component and other major components in the greater problem solving system.

Both inter- and intra-actions are most assuredly requirements and resources necessary to the operation of this mechanism. Therefore, they have been placed in the center column of the diagram but their boxes and connectors are dotted to indicate graphically their significantly different nature. While not displayed in similar diagrams later in this chapter, they should actually be shown wherever this format is used.

Each of the seven requirements for the housing model was made the objective for a submechanism to determine the constraints and requirements at this level of expansion. The results of doing this are listed in the next section of this chapter and are an indication of the ability of the approach used to achieve whatever degree of fineness is deemed necessary and useful. Figures III-4 through III-10 display the capital, public services, land use, natural resources, housing production, market characteristics, and research

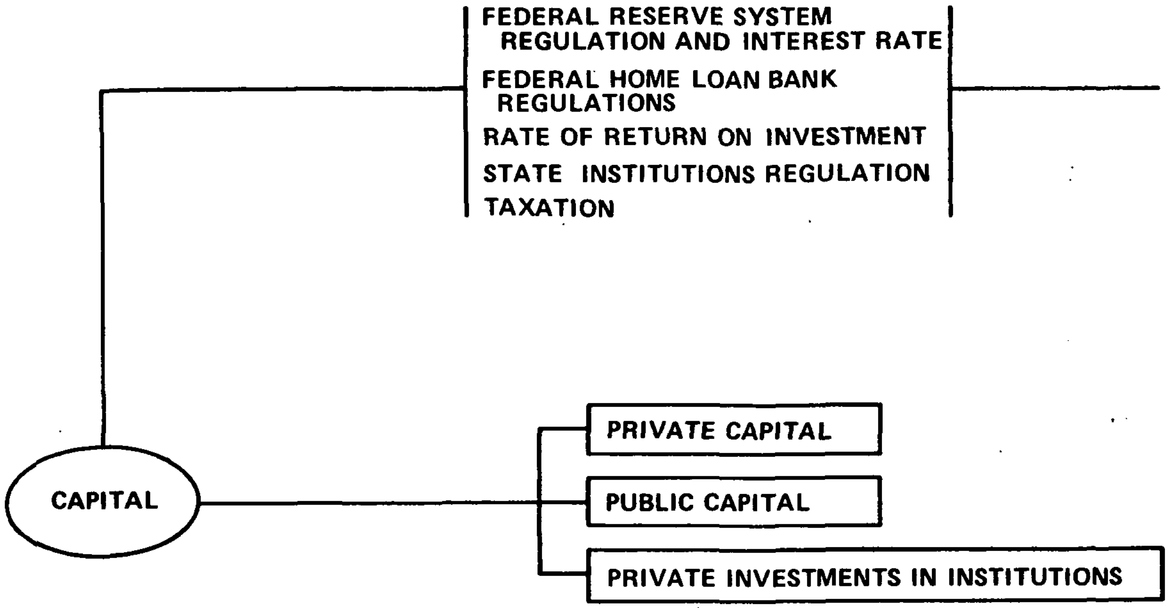


Figure III-4. Capital submodel.

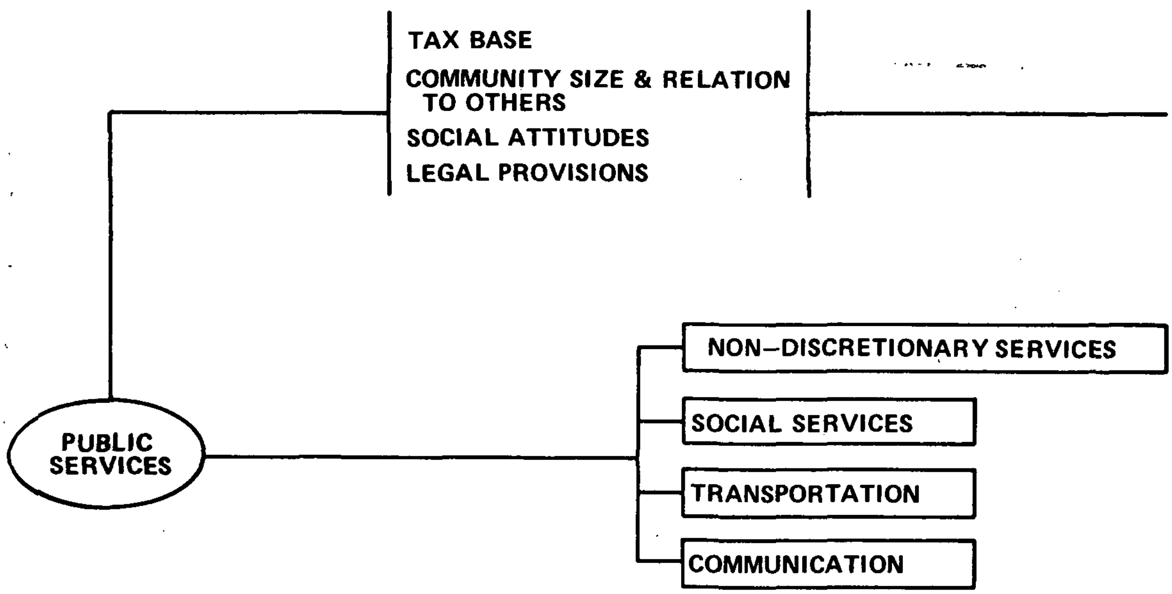


Figure III-5. Public services submodel.

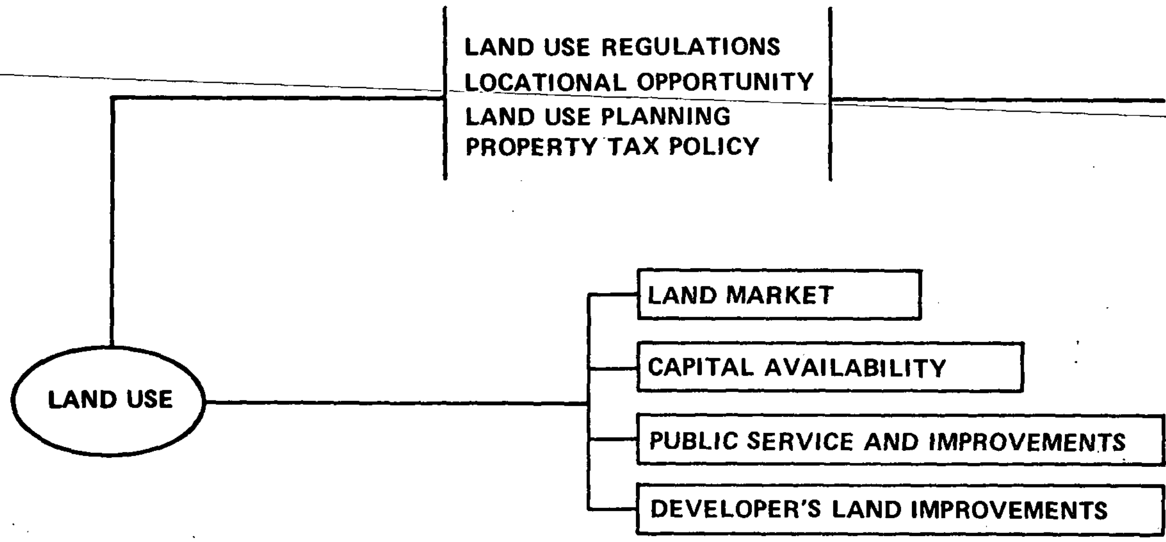


Figure III-6. Land-use submodel.

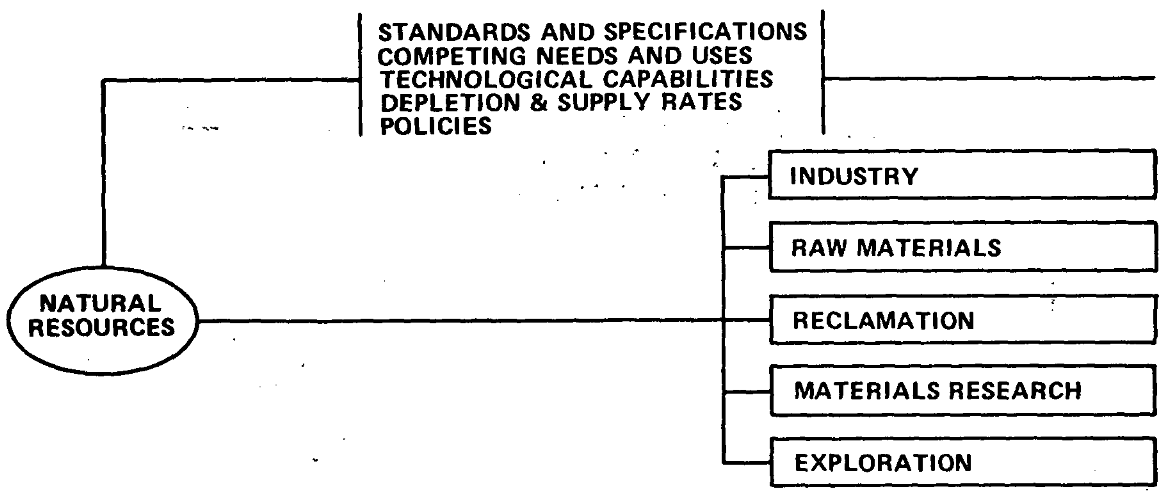


Figure III-7. National resources submodel.

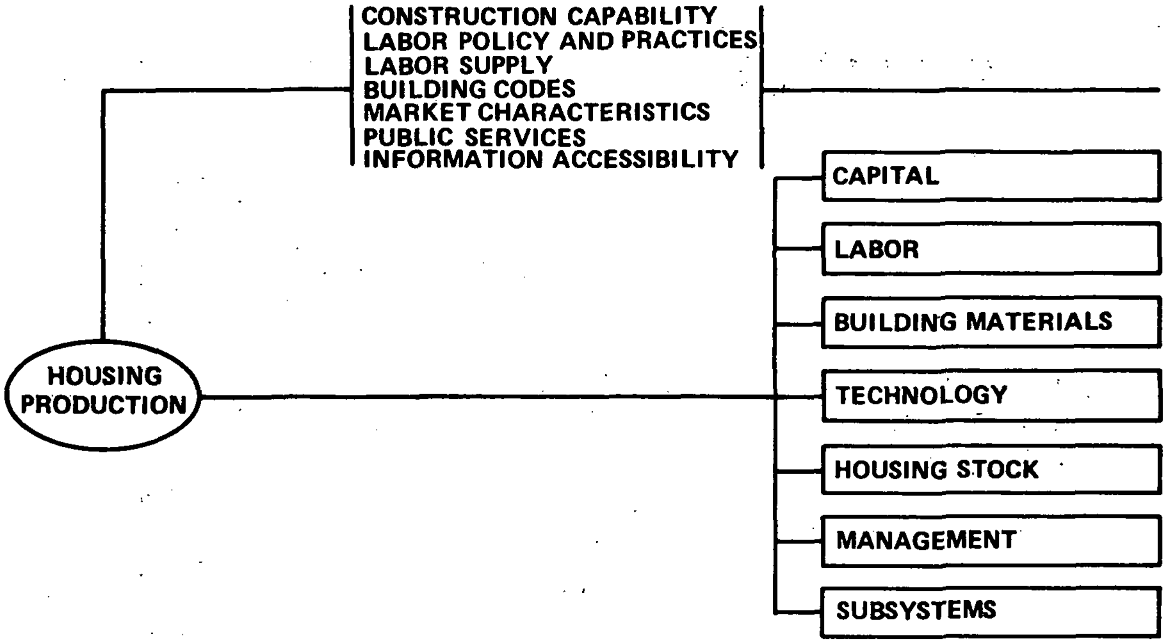


Figure III-8. Housing production subsystems.

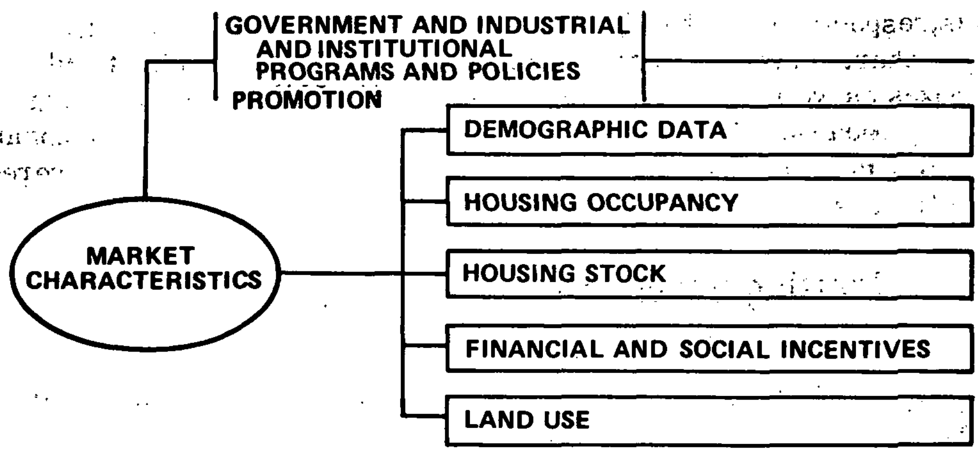


Figure III-9. Market characteristics submodel.

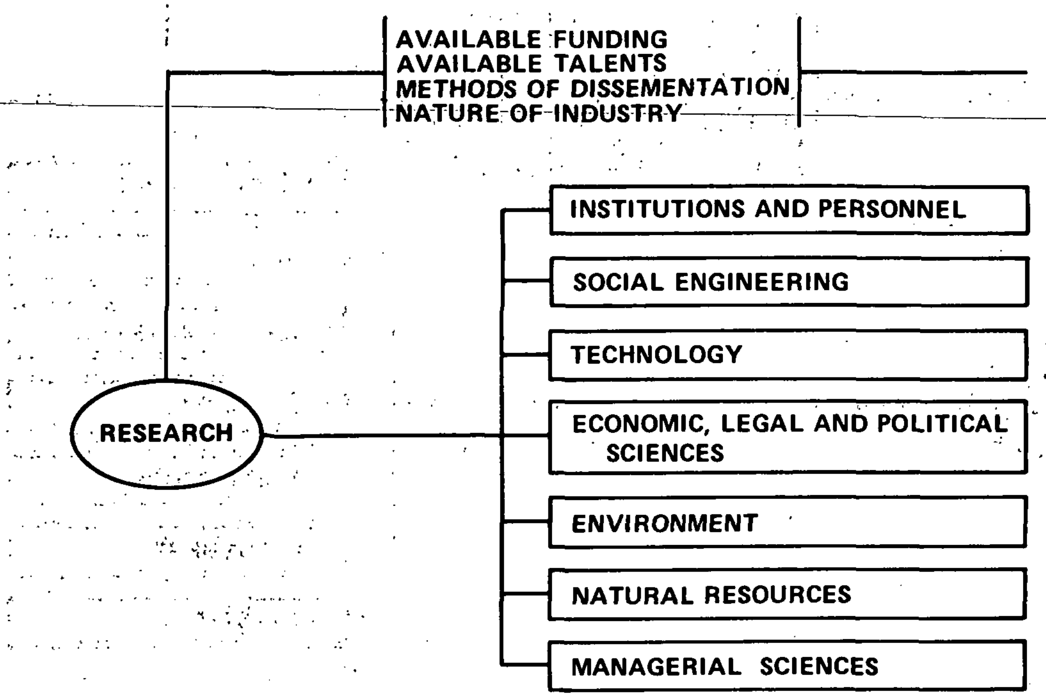


Figure III-10. Research submodel.

submodels,respectively. The right hand portion of our original overall "objective" chart consisting of the "alternative approaches, tradeoff and results; boxes as well as the feedback lines are not shown in the following charts; i.e., because this format was utilized as an orgainizational mechanism for developing the problem. Synthesis of alternatives, etc., will be covered in future chapters.

Housing Model Requirements (Fig. III-4)

Output. The capital which is available to both producers and buyers of housing.

Constraints.

1. Federal Reserve System

2. a. Regulations imposed on member banks
   b. Setting interest rate

2. Federal Home Loan Bank

   a. Regulations imposed on member savings and loan associations
   b. Setting interest rates for member savings and loan associations
   c. Can purchase secondary mortgages

3. Rate of return on investments — Amount of money an investor can make by investing capital in institutions.

4. Taxation

5. State institutions — Regulations imposed on financial institutions chartered by the state

Requirements.

1. Private capital

   a. Time deposits — Private capital invested in savings and loan institutions for specified periods of time.

   b. Demand deposits — Private capital invested in savings and loan institutions for unspecified periods of time.

2. Public capital

   a. Federal National Mortgage Association (FNMA) — Privately chartered corporation that buys and sells secondary mortgages.

   b. Government National Mortgage Association (GNMA) — Governmental agency that buys secondary mortgages.

3. Private investments in institutions — Private capital invested in such organizations and funds as insurance companies and pension funds.

Public Services (Fig. III-5)

Output. The allocation of necessary services to residential areas including education, heat, power, water, recreation, health services, etc.

Constraints

1. Tax base — Practical limit and ways in which a community can be taxed to support services without causing dire economic and social consequences.

2. Community size and location — The size and characteristics of a community and its relation to other communities with provided services.

3. Social attitudes — General attitudes and beliefs of population with respect to type and quantity of services which can be and should be provided by a community.

4. Legal provisions — Laws and regulations which govern the nation, state, and community into which housing is to be placed.

Requirements

1. Nondiscretionary services — Those services which require the transfer of a consumable.

   a. Energy
   b. Water
   c. Waste removal

2. Social services — Those services which satisfy a socioeconomic need of the population and community.

   a. Education
   b. Health
   c. Safety and security
   d. Welfare
   e. Recreation

3. Transportation — Inter- and intra-city transport of people and goods by various modes such as ground, air, and water.

4. Communications — Facilities and institutions which permit a transfer of ideas and an interaction among populace and governing bodies.

   a. Individual (telephone)
   b. Mass (radio, TV, and newspapers).

Land Use (Fig. III-6)

Output. The amount of land to be used for various uses. These uses include residential, industrial, governmental, and commercial.

Constraints

1. Land-use regulations

   a. Zoning regulations
   b. Deed restrictions
   c. National and regional land-use plans

2. Locational opportunity

   a. Economic influences through location of governmental industrial and commercial activities
   b. Natural assets of the land
   c. Available services to the land
   d. Planning information

3. Land-use planning

   a. State of the art
   b. Economic feasibility of land development

4. Property tax policy

Requirements

1. Land market

   a. Availability of land
   b. Cost of land

2. Capital available

3. Community land improvements — Provision of:

a. Health facilities
b. Educational facilities
c. Welfare facilities
d. Utilities
e. Transportation facilities
f. Public safety facilities
g. Recreational facilities

4. Site improvements — Provisions of:

a. Sewers (sanitary and storm)
b. Streets
c. Energy distribution

Natural Resources (Fig. III-7)

Output. The availability of building materials and the depletion of natural resources.

Constraints

1. Standards and specifications

2. Competing needs and uses

3. Technological capabilities

4. Supply and depletion rates policies

Requirements

1. Industry — The management, facilities, and labor associated with the production materials

2. Raw materials — Any material used in producing building materials

3. Reclamation — Processing of used materials and products

4. Material research — Activities related to the application of new materials in building

5. Exploration — Activities related to the discovery of sources of raw material

Housing Production (Fig. III-8)

Output. The number of housing units produced by the housing industry by type

Constraints

1. Construction capability at present state of art — Total all-out construction with no limit on labor and capital (all current manufacturers at 100-percent capacity)

2. Labor policy and practices — Government policy toward labor and union attitudes toward construction methods and wages

3. Labor supply — Number of man-hours of labor available by craft and location

4. Building codes — Government modifications of standards which specify and restrict methods, materials, and labor used in housing

5. Market characteristics — The user consumptions of housing; i.e., who buys or rents what types of living unit

6. Public services — Necessary facilities to service housing as constructed

7. Information accessibility

Requirements

1. Capital — Capital available to both producers and buyers of housing

2. Labor — Man-hours by craft expended to build houses

3. Building materials — Quantity by type of building material

4. Technology — Methods of fabrication and construction

5. Housing stock — Substandard units available for rehabilitation, standard units available for mergers and conversions

Constraints

1. Available funding — Money available for housing research and methods of generation

2. Available talents — Trained personnel whose abilities could be directed to housing research

3. Methods of dissemination — Means by which knowledge is transmitted to users

4. Nature of industry — Characteristics and policies of housing industry

Requirements

1. Institutions and personnel — Research institutions and individual investigation whose function includes partially or totally the generation and application of scientific knowledge to housing

2. Social engineering — Discipline which investigates man, his interrelations with other men, and his environment

3. Technology — Application of the discoveries of the physical sciences

4. Economic, legal, and political sciences — Studies related to financing, government regulations, and policies and laws as related to housing

5. Environment — Studies related to internal environment of living units and the effects of housing programs and practices on the total environment

6. Natural resources — Research directed to discovery and use and depletion of natural resources as related to housing

7. Managerial system — Studies directed toward management of housing projects and programs

This completes the listing and definition of the constraints and requirements for each of the requirements in the housing model. Detailed discussion of many of these constraints and requirements and explanation

6. Management — Organizations and individual contractors participating in housing production at management level

7. Subsystems — Facilities added to structure to provide living amenities; i.e., plumbing, electrical, environmental, etc.

Market Characteristics (Fig. III-9)

Output. The user consumption of housing; i.e., who buys or rents what type of living unit

Constraints

1. Government programs and policies

2. Promotion — Promotion refers to governmental and industrial, and institutional attempts to alter housing inclinations

Requirements

1. Demographic data — This includes geographic and numerical population data according to age, sex, family status, marital status, household status, knowledge of alternatives, ethnicity, education, economic status, and religion

2. Housing occupancy — This refers to current housing status of individuals plus availability of alternative housing

3. Financial and social incentives — Examples of financial incentives are better jobs in another area, or tax breaks for homeowners. An example of social incentive might be the increasing public concern about overpopulation.

4. Land use

Research (Fig. III-10)

Output. Practical and theoretical knowledge as related to the design and construction of housing and living environments

of some of the inter- and intra-actions involved are contained in the next four chapters of this report. Specifically, Chapter IV includes technological considerations, Chapter V institutional considerations, Chapter VI environmental considerations, and Chapter VII sociological considerations.

Now having examined the housing model and its requirements in some detail, the other requirement for a decisionmaking mechanism for housing (a management institution) will be considered.

Management Institution

In Figure III-11, the management institution required to operate the housing model is expanded to its first sublevel. The specific organization for this task has not been identified. The nature of this organization will begin to develop as the model itself takes form along with the concurrent identification of its specific users. This subcomponent would then become the topic of additional systems studies. At this point, only general requirements which would apply to any final institutional configuration have been identified. These requirements include:

1. Funding — Required to perform management activities.

2. Facilities — Within which to operate and then at a location and of a specific size and type necessary to meet the more detailed management requirements that are yet to be spelled out.

3. Organization — The requisite personnel and distribution of tasks.

4. Responsibilities — Those activities entrusted to the management to meet the criteria of its formation.

5. Information — The raw material which management needs to operate the model effectively.

One observation to be made in passing is that the decisionmaking mechanism is not a housing information system. However, its development should trigger and help configure such a system by indicating the levels of data required.

The more important elements indicated in this submechanism are the constraints and criteria. They can be seen to have evolved directly from the overall constraints and criteria of the original objective display. Any management, regardless of its specific nature, must be adaptable to change. It must be efficient, up-to-date, and attractive to users and supporters.

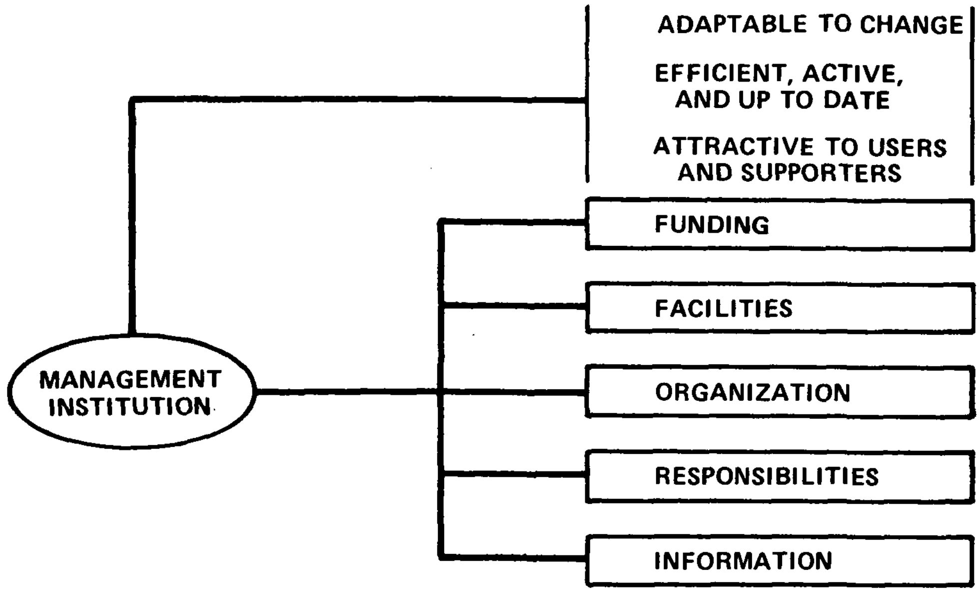


Figure III-11. Management institution.

Summary

The evolution from sensing housing as "a system as-a-whole" to the generating system used to expand the objective "a decisionmaking mechanism for housing" into its components and subcomponents has been described. These components and subcomponents have been identified and briefly discussed in this chapter. As previously mentioned, further consideration of many of these components and subcomponents is contained in the next four chapters.

CHAPTER IV.

TECHNOLOGY

CHAPTER IV. TECHNOLOGY

Introduction

Technological Innovation in the Housing Industry. The U. S. housing industry has not been completely stagnant with regard to innovation. Developments have been made to reduce on-site labor cost such as the use of pre-assembled trusses and sheetrock wallboards. The modular portion of the industry has risen from insignificance, the pre-assembled half-houses are no longer rare sights on the highway. These developments and others like them have come about slowly and have encountered strong resistance. Although housing is recognized as the least efficient major U. S. industry, there is no great effort toward change in the method of construction, and no great show of developed, new, and different products ready to market. Any industry would exhibit these characteristics if it had no research and development program to bring about and apply improvements in its methods products continually and forcefully. The housing industry lacks this very factor.

As has already been pointed out, the U. S. housing industry is severely fragmented. There are thousands of companies and many individuals contributing to its output. The largest company accounts for less than 1 percent of the product. This division into many small companies implies that none of them have the capital resources to organize for long-term operations and for that reason direct only a miniscule fraction of their funds into research and development on a continuing basis.

How can innovation enter an industry like that? There is a possibility that trade associations can enter the picture and provide a collective research program such as the Fractionation Research Institute has done in the petroleum/chemical industry. It just has not worked out that way. What work they have done has tended to be directed toward individual material or basic subsystem. These efforts have led to improve concretes, glue-laminated beams, composite construction, etc.

The other route for technological innovation is through the vendor. He has an incentive such as building up his sales to the housing industry. He can do this by offering a better product. Vendors are often discouraged from investing heavily in housing research and development since vast markets cannot be guaranteed and cyclic changes have not been avoided. Many of the most unique approaches, such as aluminum studs, have come from established companies in other fields: materials processing, petrochemicals, and

electronics. Their cash flows are very large and their research and development well established. It appears that when one of these appears in housing development, it has resulted from an effort on that company's part to exploit its existing technology in new fields and not from a deliberate decision to enter the housing industry.

The housing industry appears to be incapable of boot-strapping. It cannot do its own research and development to bring about technological innovation. It is dependent on its trade associations, its vendors, outside industries whose emphasis lies elsewhere, and gratuitous donations from research institutes, outside industry, and government organizations such as NASA and NBS. The Technology Task Group has directed efforts to point out areas in which technological innovation, in development in many areas and categories, may have applicability in the housing industry.

Each technological innovation must be evaluated before it is applied. The innovation which is a scientific success and an economic failure is infrequent. An economic evaluation is a part of each new development. This analysis can be more misleading than helpful, though, if all of the factors which affect the housing value are not included. There has been a tendency to look closely at first costs and to minimize the effects which relate to those continuing costs which accrue when housing is occupied. These continuing costs seem small when stated on a monthly basis, but accumulate quickly over a few years. Failure to consider these operating costs has led (in 1966) to savings and loans companies repossessing many units and then spending \$ 5000 to \$ 10 000 per unit in order to place them back on the market. A policy of subsidizing a 40-year mortgage on a structure built at minimum cost could result in new slum areas only 10 to 15 years old.

Life Cycle Costing. Life-cycle costing has become more prominent in system analysis and has been considered in government contracting. Not only are the first costs of the project considered, but the maintenance and operating costs are included to obtain an economic measure of the life-time costs associated with a structure.

The conventional economic analysis is lacking in another aspect [IV-1]. It considers only those factors which contribute directly to the first of following costs of the structure; i.e., the costs involved in building (materials, labor, etc.) and operating (maintenance, heating, etc.). Each housing structure has costs and benefits associated with it which are not included in that analysis. Primarily, there is no measure of effectiveness for the building and, further, there is no evaluation of the effects the building

has on its surroundings. Three types of costs, then, must be considered to obtain the complete effect of the structure: (1) conventional technological cost, (2) sociological costs and benefits, and (3) costs and benefits which the construction has on its environment.

The conventional economic analysis is further limited in that it considers cost effects only for the builder and first direct user. While beneficial to the user, the structure may be detrimental to its community. The effects of each of the costs delineated above must be extrapolated beyond the first direct user. To evaluate the total benefit of the housing structure its cost-benefit evaluation should be extended beyond the direct user: to the community, to external agents, and to subsequent potential users.

Total Benefits. When a total benefit evaluation is made, the conventional economic analysis is found to cover only 1 of 12 possible costs. Technological considerations may be extended to cover another three: studies of the economic effects on the community, external agents, and potential future users. To continue into the other areas, completely different approaches must be applied. The benefits and costs on a social basis are not resolvable by technological evaluation. Studies in sociology are required here. To extend the work to include its environmental effects requires a scrutiny of the community's capability of supporting the structure from immediate resources in construction and from future supplies to operate it. Natural resource studies support this work. These interrelationships occur within a community, local or national. This community is already structured with governmental and financial institutions to facilitate such studies. Input then becomes necessary from studies of the institutions as they relate to housing in the community. Thus, the contribution of technological investigations is found to cover only a portion of the total benefit evaluation and must be integrated with work for sociology, natural resources, and institutions studies for completeness and context. Table IV-1 shows the interrelations of the various costs and benefits which are related to housing decisions and makes reference to the areas which must be investigated to study them.

TABLE IV-1. HOUSING COSTS AND BENEFITS

Type	To Whom			
	Direct User	Community	External Agents	Potential User
Economic or Technological	Technological	Technological Resources	Technological Institutions	Technological Sociological
Sociological	Sociological	Sociological	Sociological	Sociological
Environ- mental	Technological Resources Sociological	Resources	Institutions	Sociological

Technological Contributions in the Housing Model

As the housing system was studied and diagrammatically presented in Chapter III it was determined that major technological contributions could be made in materials, engineering, and management processes.

Materials. Building materials form one of the components of any process of housing production. It was observed in Chapter III that materials is a requirement in the housing production model and materials research is a requirement in the Natural Resources Model. More so than other technological aspects of housing production, it is the one area in which the majority of innovations have occurred, both in the discovery of new materials and in the development of new processing techniques for raw materials. The types of materials employed in housing construction are myriad. It is not our purpose to classify and list all such materials. For purposes of discussion and to indicate the tradeoffs and discisions that must be made between material selection and other aspects of housing production, we shall classify building materials by material class (wood, concrete, metal, paper, plastic, composite, etc.) and by the degree of finish and fabrication (raw materials, semifinished products such as planks and two-by-fours, high tolerance and finished panels, etc.). By type of material, we shall mean some combination of material class and degree of finish and fabrication. The cost, quality, and basic material properties (such as strength, weight, insulating characteristic,

fire resistance, acoustic transmittivity, etc.) will in general be a function of the type of material (some combination of material class and fabrication).

There is a strong interaction between the type of building material employed and the other components of housing production. The type of material chosen dictates the labor skills, technology and managerial organization required, and vice versa. A mismatch between these components and/or a failure to realize the effect of certain constraints such as labor practices, financial practices, and social attitudes toward materials can lead to a misjudgement in the use of materials, increased costs, and outright rejection of the final product. For example, where skilled carpenters are being used in on-site construction, there is little reason to construct with high quality lumber since such laborers can work imperfect lumber into desired forms. Also, it would probably not be advisable to introduce exotic materials since the lack of familiarity of such workers with the properties of the new material may more than offset any advantage that could be gained by the introduction of the material.

In general, the main influx of new materials into the construction industry has come from more advanced technologies. This often leads to difficulties. In general, the building field is highly conservative and slow to accept change. The success of a material is usually dependent on its ability to be produced in some form such that its appearance resembles that of more conventional building materials (e.g., aluminum siding, aluminum and steel studs, wood-like plastic panels, etc.). People seem to have attitudes and opinions as to what high quality building materials are: floor material should not "give" and good cabinet material should have a deep sound. Similarly, trying to fake the appearance of traditional materials can lead to sociological reactions when these substitutes do not possess all the properties that their appearance suggest. The substitutes that are out of the main stream will probably fail. The "Monsanto House of the Future" which used a revolutionary design and treated plastics as plastics is a prime example. The metal "Lustron House" also failed to win acceptance due to similar reasons. However, plastic and metal substitutes to conventional building materials are now commonplace. The true potential of material innovation cannot be realized until there is a change in popular attitudes, labor practices, and codes.

Traditional building materials are compatible with the current state of the building industry. Innovations are incremental in nature and reflect current building practices. The introduction into housing

of materials developed for other applications means that probably all the unique characteristics of the material are not fully utilized or that it lacks some desirable characteristic which is unique to housing applications. Modern materials are designed with some application in mind (e.g., most NASA materials are meant to be used in spacecraft that operate in extreme environments) and those applications are usually not housing.

With the advent of other innovations in housing design and production, concurrent advances in the design of building materials would occur and would be beneficial. However, at present, houses are not designed in any engineering sense; they are only assembled according to a rigid set of rules. An engineering design of building materials and, in turn, living units requires a determination of the characteristics important to housing design; e.g., strength, weight, fire resistance, acoustic insulation, thermal insulation, light absorption, and emissivity. Materials should be designed to meet acceptable performance criteria expressed in terms of these parameters. Ultimately, one would want to establish efficiency parameters in terms of these parameters to more effectively use the material in design situations. However, the state of the art of housing design and a lack of understanding of the suitable criteria prohibits this at present. NASA contributions to minimum weight design and materials efficiency parameters for such design could be used as a guideline; however, such criteria should not be used in housing construction with a careful examination of the requirements particular to living units.

The Performance Concept in Building Codes. Standards and local building codes are discussed in Chapter III as constraints on the utilization of technological innovations in the housing model. By definition, a standard represents the consensus of a group of experts on the state of the art of implementing a specific task. On the other hand, a building code is a regulation pertaining to health and safety. Welfare regulations have been added recently to the purposes of building codes.

A constraining aspect of local building codes stems from their evolution. They are usually written after the fact has taken place; thus, they represent protection against reoccurrence. The several hundred local building codes existing throughout the United States lack uniformity, flexibility, and adaptability to technological innovations. These characteristics are usually found concealed under the sincerity of health and safety protection criteria.

The National Conference of States on Building Codes and Standards (NCSBCS) which represents all states and territories of the United States

has recognized the need for cooperation in providing uniform comprehensive building codes and standards. The purposes of the NCSBCS are stated here to focus the attention on the problem areas of concern [IV-2]:

1. To provide a forum of the States for discussion of problems related to the administration of programs pertaining to building as carried on by regulatory officers of the States and to provide a mechanism for the exchange and developing solutions to problems identified by the Conference.

2. To assist in the development of programs leading to the adoption and administration of uniform comprehensive building codes and standards among the agencies involved in the regulation of construction within and among the States where such uniformity is deemed necessary for interstate purposes.

3. To develop an effective voice for State officials in the American National Standards Institute, Inc., and the committees of nationally recognized standards generating organizations.

4. To develop standard and code practices that will encourage the introduction and uniform recognition of innovations in building materials.

5. To support the evolvement of comprehensive training and educational programs at recognized educational institutions for the personnel connected with the enforcement of building regulations.

6. To further utilize the scientific environment of the Building Research Division at the National Bureau of Standards and other research research facilitities in support of Conference and State identified building research needs in the field of performance criteria and their measurement methods.

7. To foster cooperation among government officials concerned with building regulations, and between these officials and the design, manufacturing, business, and consumer interests affected by their activities.

There is no question that most changes in the present building codes will be directed toward the performance concept. The performance criteria of a material, component, or system can be defined as the fulfillment of the requirements for the intended user without regard to the detailed processes employed in achieving the result [IV-3]. Evaluation mechanism in the performance concept is an integral part of the performance requirements.

The NCSBCS in cooperation with the NBS is working toward establishing a Bureau of Accreditation Programs to evaluate the whole housing system [IV-4]. These will involve quality and reliability programs in which the states will provide the system for accreditation, and the NBS will set the measurement techniques. New York City, among others, has taken initial steps toward the development of a performance code system.

There is a general agreement among those in industrialized housing in criticizing the present building code systems. On the other hand, they are overoptimistic in their attitudes as to the constructive contributions of the performance approach and/or a unified code system to the housing field. C. M. Mahaffey, Director of the Building Research Division, NBS, believes that if performance criteria are adopted, the building industry will introduce innovations on a large scale, and will improve the industrialized housing market to meet the demand for housing and at a profit to the producer [IV-4].

The Building Sciences Act of 1971 [IV-5] introduced to Congress on May 13, 1971, as an amendment to the Housing and Urban Development Act of 1970 requests the establishment of a National Institute of Building Sciences. The task of the institute is:

> "To provide a more effective approach to the problem of developing and maintaining a rational relationship between building codes and related regulatory requirements and building technology in the United States, and to facilitate urgently needed cost-saving innovations in the building industry."

The bill cites that the lack of achieving nationally accepted standards and other technical provisions for use in federal, state, and local housing and building regulations is an obstacle to efforts by and imposes severe burdens upon all those who procure, design, construct, use, operate, maintain, and retire physical facilities, and frequently results in the failure to take full advantage of new and useful developments in technology that could improve our living environment. The institute will be entrusted with the development, promulgation, and maintenance of nationally recognized performance criteria, standards, and other technical provisions for maintenance of life, safety, health, and public welfare suitable for adoption by building regulating jurisdictions and agencies, including test methods and other evaluative techniques relating to building systems, subsystems, components, products, and materials.

Research areas in which performance criteria are used to expand the use of the performance approach in the development of building codes have been investigated in recent studies [IV-3, IV-6]. This task is at its early stages of development and related research is very limited. The research recommendations cited in these references number in the hundreds. The implementation of the proposed research only will require an all-out effort to construct the basic scientific data needed. On this basis alone, it is easy to conclude that the desired performance code concept will have to evolve with time, and it will not be realized in the near future.

<u>Housing Subsystems</u>. Housing subsystems, a requirement for housing production, are the essential facilities which make the basic housing structure livable. Foremost among these are the mass transport system to provide for water and for liquid and slurry waste disposal, the electrical system to provide light and heat energy, and the environmental system which can provide a comfortable living atmosphere within the structure. When technological innovation is applied to subsystems, improvements to their operation can lead to initial and subsequent savings to the user and improvements (or substantial changes) in their basic design can add savings to the future user in his maintenance and replacement costs.

In conventional housing construction, the components which make up the various subsystems are shipped to the building site as individual pieces. Then, the sequence of overall construction is rough framing, rough plumbing, electrical and heating, testing, closing in, mechanical finish, and architectural finish. This, of course, requires a great deal of on-site skilled-trades labor to assemble the various subsystems and adds a significant amount to the first cost of the housing unit. Thus, it is not surprising that many of the technological innovations presently being considered for subsystems are those which show real promise for cost reduction in assembly.

Let us consider some of the innovative concepts in subsystems which are presently being considered. These include factory preassembled service walls [IV-7] that contain plumbing trees, vents, flues, and electrical services, factory preassembled cores [IV-8] which contain all "utilities" functions (toilet-bath, kitchen, hot water, heating and electrical distribution center) as well as structure, and factory preassembled split cores [IV-9] which consist of separate kitchen, bath and utility cores, or some limited combination thereof. The key to achievement of cost reduction in all of the concepts is, of course, the replacement of all or nearly all on-site skilled-trades labor by less skilled factory labor.

However, there are considerations other than reducing the first cost of the housing unit which need to be considered in any innovative approach to housing subsystems. These considerations include the following:

1. Need for performance standards — Such standards, if developed for each subsystem, would help remove housing codes as a barrier to innovations in concepts and use of materials. This could be a very important factor in developing the full potential of innovative technology in subsystems.

2. Planned obsolescence — There seems to be a general failure to recognize that many components of the various housing subsystems do not last the life of the housing unit. David Pellish of the New York Urban Development Corporation recommended that mechanical systems should be easily replaced by simply plugging them in. This would allow the owner to purchase and plug them in himself. Another possibility might be for the owner to rent rather than own such plug-ins.

3. Warranty and servicing — Recent legislation in California indicates that any product which carries a warranty of any kind can be subject to legal action in the event of malfunction of that product. If the installing contractor for the product is no longer in business, the legal action can revert directly against the manufacturer of the product and the consumer can collect up to three times the cost of the original installation. Since the producer of housing subsystem components has virtually no control over their installation, a plug-in approach could be a solution to this problem. Servicing mechanical units in housing subsystems is fast becoming a major problem. Easy access for maintenance and use of plug-ins need to be considered.

Some specific examples of housing subsystems include:

1. A redesign in electrical subsystems has been proposed. The control functions could be accomplished with low-voltage connectors. The on-line switch would be located near the controlled facility but it would, in turn, be controlled by a low-voltage switch placed at the most convenient location to the user. Present practice requires internal installation of high-voltage (110 wiring to every switch and facility. Using low-voltage controls, only the major facility would be served by high-voltage wire. The low-voltage wire for the control system is much less expensive than high-voltage and would not require internal installation. After installation on the outside of a wall, it can be covered by a coating of paint.

2. One of the NASA developments that may be useful in electrical subsystems is the flat conductor cable [IV-10]. This cable is especially suitable for the low-voltage application above. It may enable the entire

electrical system to be externally installed. Savings in initial installation cost and in subsequent maintenance and modification costs may accrue.

3. The multiphase, counter-current flow, self-expanding contracting pipeline may not have immediate application.

Industrialization Potential of U. S. Housing Industry

The Nature of Industrialization. Much discussion and not a small amount of disagreement currently centers on the question of the degree to which the building industry is industrialized. At least one reason for the continuing dispute stems from a lack of general agreement as to what constitutes industrialization. Yet, there are many available definitions, most of which contain a number of elements in common. A composite of these definitions emphasizing those common constituents would include at least the following:

1. Replacement of manual labor by mechanization wherever possible.

2. Standardization of product and processes to achieve continuity of mass production.

3. A strong, well-organized and identifiable market exhibiting a steady flow of demand which will sustain continuous production.

4. Integration of and control over the various stages of the total production process.

5. Continuing research, experimentation, and development as an integral part of that process.

In summary, mechanization, organization, and control are involved here — the familiar "management of process." In terms of the building industry (or more properly, its housing component), this could be restated as full integration of design, marketing, production, assembly/installation, and research and development all under one roof; e.g., by a single company in each instance.

The Swedish Industries Building Group refers to this form of control as product responsibility [IV-11]. With this level of control, the Swedish

group (known as the IBU) points out that the design of the product can be brought into line with the most efficient methods of production. In this way, typified solutions are possible upon which serial production within one and the same company can be based although building sites vary. Since product responsibility along with production methods would rest with the producers, continued development of the former would be as important as that of the latter. The IBU then sees the present tendering (bidding) procedure prevalent on both sides of the ocean which depends upon lowest cost, almost exclusively, for projects fixed in every detail as being replaced by a tendering procedure in which not only price but also product design, quality, time of delivery, and product guarantee become weapons in the competition.

Since the building company and not the client with his professional advisors would then be responsible for the purchase of subsystems and materials, the IBU sees competition with the industry as being widened and stimulated. In this way, companies will compete by means of continued product development and development of production methods, rationalization, efficient cost control, and marketing in a way which, from the point of view of price and other properties, will best satisfy consumer demand. Thus, competition, the IBU's second theme, is seen as a significant means of increasing productivity.

The final requirement stated by the IBU for increasing the productivity of the building industry (e.g., a term synonymous to industrialization for some and as we shall see, not so for others) is continuity. In the construction industry, this is taken to mean not only continuous, relatively unchanging and specialized products typical of other industries, but, also, a continuity of demand. The latter is particularly important to the industrialized producer who has to be fairly certain of consumer demand significant enough to provide fair assurance that he will have enough sales to amortize his initial outlay for plant, production equipment, initial stock of materials, and general training and management overhead (all are elements which the conventional on-site builder is not particularly concerned with, since his operations are usually local in scope; he can identify targets of opportunity within his local sphere and keep his commitments relatively close to effective demand, since he literally "carries his factory around on his back").

The Need for Industrializing the Process of Producing Housing. The preceding is but one of many possible views of industrializing the process of producing housing. It is clear that at least in gross terms that account does not describe the operations and methods of delivery in the construction industry in this country, in general, nor its housing component in particular

at this time. In fact, there are many in this country who see little reason for our housing industry to become industrialized according to this or any other similar model. Many others actually fear the results of industrialization. Thus, before flat, unqualified instances that we industrialize, we must first address ourselves to the following questions:

1. Is there a housing crisis?

2. If there is a crisis which implies a current or identified future demand (at this level, imagined or effective demand) exceeding current or identified future supply? Is the housing industry in this country, as presently configured, able to meet these additional requirements within prestated time constraints and at requisite levels of costs and other considerations? If it is not so capable, how might it be most effectively reconfigured in order to do so?

3. If the industry is not capable and requires reconfiguration, is the previously described European model (which is most visable to us and implies at this time the use of heavy precast concrete panels) appropriate for us? Alternatively, are their variations of it as well as totally different approaches more appropriate to our specific needs? In a phrase, is industrialization of whatever form necessary? To answer the latter question we must know from where we begin; i.e., is the present industry actually already industrialized and, if so, to what degree?

4. Does industrialization, if carried out on a large scale, necessarily imply unending monotany in the resulting environment which would be contrary to the objectives identified and stated in this report?

In all instances in this section, these questions are asked in the context of industrialization and its effect upon the direct cost, efficiency, speed, and quality of production of housing units.

Whether or not there is a housing crisis is treated elsewhere in this report. The significant thing is that two presidential commissions have identified the existence of a crisis. The results of one of these commissions have been translated into legislation in the form of the 1969 Housing Act which sets a 10-year numerical quota for the production of housing units. This quota requires, in turn, an annual production rate considerably above the present rate as well as above the rate for the best single year since World War II. Thus, significant political as well as private actions have been taken based upon this goal.

The diversity of American society is similarly reflected in the attitudes and actions of its housing industry. Each actor in that industry looks to others as the reason for his not being able to meet his responsibility. To do so, he only needs to be given the proper resources. The conventional housing industry fits this description and generally sees little need for industrialization per se to increase production rates.

Others, both in the popular as well as the technological press, view the situation differently.

Walter McQuade, in the May 1, 1969, issue of Fortune Magazine, expanded upon the popular pasttime of making analogies between the production of housing and the manufacturer of automobiles to quote [IV-12]:

> "If the production of automobiles in the U. S. were as primitive as the production of urban housing, the customer who wanted a new house would go to his local service station. The service station would order the wheels through a jobber from the Budd Company, the motor from Continental Motors, the transmission from Borg-Warner, the seats and upholstery from Fisher Body, steel sections to make the chassis from a local foundry, and various parts from still other suppliers. It would all be assembled on the asphalt beside the gas pumps. The car would not be as sleek as a checker cab, or run as well, probably, and it would cost more than a new Buick in Bolivia."

McQuade admits that more and more of some kinds of construction being done each year bear the mark of increasing industrialization. But, in general, the production of housing in the U.S. cannot at present be called an industry either in approach or performance; a strange situation for a business approaching $ 35 billion a year (1971).

Richard Bender [IV-13] puts the question in stronger terms: "How can it be that the question of industrial building is still claiming our attention? How is it that in the age of electronic computers, nuclear energy, and supersonic travel, we still question how, and even whether, to go ahead with the industrialization of the building process? How can such a major sector of the world's economy be so retarded that, not until recently, had the industrialization of building been taken up as a subject for serious discussion? Other fields have been industrialized for generations. Many are approaching the stage we call automation. What then is so exceptional about building?"

The exceptions about building, particularly housing, are what this report is about. On balance, it must be said that the production of housing will have to trend further towards some form or forms of industrialization if this nation is to meet the goals it has set for itself. The following are two of many examples which might be cited in support of this conclusion.

At the time the legislation establishing the goal of 26 million units in 10 years was passed at the end of 1969, the construction force was estimated to consist of 2.86 million workers. During the 3 years previous, it had grown by less than 3 percent [IV-13]. The situation had become serious enough to reflect itself in the practice of "pirating" skilled labor tradesmen, not unlike that which occurred in the electronics industry a few years ago. More concrete evidence of the seriousness of this shortage was that while the cost of materials had generally gone up only about 1 percent per year (and in some instance, even dropped), the cost of skilled-on-site construction had successive annual increases of 12 to 15 percent per year, including both wages and benefits. (This is in spite of the fact that less than 50 percent of the work force was and is unionized.) Thus, even if, as some studies show, labor productivity in construction may increase in some cases by as much as 2 percent per year, this nowhere nearly offsets those wage increases that continue on an increasing scale to this day. By some estimates, this factor alone accounts for an increase in overall housing costs of 3 to 4 percent per year [IV-14]. The problem can be viewed in another way. A 1969 survey by Owens-Corning of 17 cities found that the construction of a house took 1 to 6 weeks longer than the year before with the most reoccurring reason being given as the shortage of skilled labor [IV-15]. The scarcity of labor is even more significant in terms of the national goal. With our present labor force and likely return to a 3- to 4-percent unemployment rate if the economy stabilizes, where will the required work force come from? With the current force of construction workers and present methods of construction, it is estimated that with all other factors favorable we could produce at the maximum 1.8 million dwelling units per year [IV-16]. If, somehow, decreasing participation in apprenticeship programs would be reversed and restrictive hiring practices significantly relaxed, which is unlikely, then the trend of increasing shortages in the highly skilled carpentry, plumbing, electrical, and sheet metal trades could begin to be reversed. Even so, most experts doubt that a sufficient number of people could be found, much less trained, in time to get private building up to a sustained rate of even 2 million dwelling units by 1972. That fact does not even consider the corollary increases in skilled labor requirements for rehibilitation of existing structures plus that required for potential new government as well as private

housing programs and related educational, highway, sanitary, commercial, and industrial facilities that must accompany significant increases in homebuilding [IV-17]. For that reason, many builders believe that any sudden leap toward a 2.6-millon dwelling unit production without substantially increasing the present labor pool and/or revising present construction methods would very sharply increase already inflated construction costs [IV-18]. If a production boost of 1 million additional units per year were possible, at an assumed cost of $ 20 000 per unit, this would then imply an annual increase in construction expenditures of $ 20 billion per year, assuming constant wage and material costs. But because of increased demand upon labor and materials, the latter would probably raise the cost of that unit by 20 to 30 percent, requiring an annual increase in housing outlay on the order of $ 30 billion or more [IV-19].

As figures recently released by HUD show, not only has the total goal been advanced to 28 million units, we have failed to get up to speed during these first few years of the decade we have allowed ourselves. Consequently, the projected rates towards the middle of the decade will have to increase far beyond the 2.6 million original average. In reality, the HUD figures project this buildup at the end of the period, but it would seem to be fallacious in the absence of any clear indication that this need will continue beyond the decade, not allowing for a tapering-off period. We have already had too many examples of industries built up under crisis conditions only to face disaster as the needs, interests, or value systems of society suddenly shift to new directions.

The second example is perhaps the more controversial because it has to do with construction costs and potential cost savings. The controversy is understandable in view of the wide fluctuations in three significant figures. The first is the percentage of total cost of a housing unit attributable to direct costs (labor and materials) of construction — it ranges from 33 to 65 percent. The second is the percentage of these direct costs that potentially can be saved through industrialized construction (total savings minus cost of plant, equipment. overhead, etc.) — this ranges from an estimated no savings to a high of 27 percent. The third figure is the final savings in out-of-pocket monthly costs to the actual consumer because of industrializing the production process. It ranges variously from 3 to 4 percent to a highly optimistic 20 percent.

Legitimate reasons for the significant variation in each of these figures can in part be attributable to geographical variations in specific component costs such as land, labor, and building materials. Savings

accruable to industrialization can hardly be determined from the minimal amount of all forms of fully industrialized housing actually put into place in this country at this time. Projected savings in this country, based upon the longer period of European experience, is conjectural at best. Perhaps most important of all, these variations reflect the vast diversity across the country of accounting for all of the direct and indirect expenditures in housing by the time they are translated to final consumer cost. This is another way of saying that available, reliable construction data are of very poor quality compared to similar information available in other sectors of the economy.

For purposes of this argument, it is useful rather to quote a savings figure which the conventional industry itself has stated; namely, a maximum savings of $ 1000 on a $ 20 000 unit. While a 5 percent savings to the individual consumer may not appear to be much (the consumer pays more than that to a broker for the priviledge of buying an existing house on the market), the size of the building market makes such a savings in the aggregate quite significant indeed. Assuming a $ 20 000 average unit cost, the effect, for instance, on the 6 million units projected as government subsidized totals a $ 6 billion savings in a 10-year period. That is not an inconsiderable savings in terms of either the part returnable to the taxpayer or the amount that might be thereby freed for additional production or research and development support.

In conclusion, while savings in the aggregate are themselves significant enough to espouse the cause of industrialization (and which will undoubtedly increase as on-site labor continues to rise much faster than factory labor), there are numerous other advantages. In many instances, there are corollary disadvantages. Both deserve listing in terms of the industrialization of the housing production process.

Opportunities and Constraints of Industrialization. Basic advantages and economies stemming from factory fabrication of housing include the following:

1. Better organization of the work with less waste in movement of men and materials

2. Improved materials handling

3. Better quality and cost control

4. Lower material costs through timed and quantity purchasing or, conversely, utilization of higher quality materials

5. Lower levels of material waste through preplanning

6. Elimination of much of on-site loss and destruction of materials because of adverse weather, drop-shipment damage, and vandalism

7. Improved product control by having basic design engineering and production under one roof

8. Utilization of lower labor skills with minimal skilled supervisory people required, since work can be preplanned and division of labor can occur

9. Shorter on-site "construction" time with concommittant reduction of high carrying cost interim (construction) financing

10. Better (steadier) utilization of labor by avoiding on-site weather-caused work stopages

11. Easier integration of subsystems, structure, and often, finishes during production

12. Ease of final finished application and protection of those finishes

13. Lower professional fees (if not in-house) through "volume" contracts

14. Shorter time between site opening and job completion with attendant quicker user occupancy or "rent-up;" e.g., quicker commencement of income stream

15. In some instances, opportunity to tailor use and type of materials selected to production sequence as well as to user needs.

As might be expected, some of the above advantages are reduced by a number of the following disadvantages of factory fabrication:

1. Amortization of capital investment in plant, equipment, inventory, and transport and site erection equipment, thus requiring a sufficiently large or extended as well as stable aggregated market for the housing product

2. Transportation costs of the finished product

3. Maximum economic transport radii from the plant, varying according to the nature, size, and weight of the product being shipped

4. Requirement of uniform code and zoning ordinances within a given marketing area

5. Restructuring of labor trade divisions to suit factory production and/or resistance by organized labor at factory or site to the industrially produced product

6. Limitations in levels of variety because of requirements for levels of standardization

7. Limitations in design flexibility, often severe, due to design requirements not germane to final user needs (e.g., transportation constraints)

8. Occasional requirements for suboptimization in structural or mechanical design because of requirements again not germane to final user needs (e.g., design for structural stresses because of lifting that are in excess of in-place dead, live, and lateral loads).

Of course, the particular aggregation of advantages or disadvantages as well as the specific impact of each varies with each mode now in use as well as between individual building systems within that mode. Generally (but with some important exceptions), most advantages, if they appear, are accompanied by certain disadvantages so that a kind of balance occurs as a result of the required tradeoffs.

The interrelationships between the above factors are so complex as to cause even the most enthusiastic supporter of industrialization to be cautious in ascribing cost benefits alone as a reason for proposing this direction. Rather, most agree that industrialization promises higher volume at a faster rate while equalling or, as time goes on, comparatively bettering on-site cost at a modest rate. These attributes would seem to be in support of the national goal.

Measures of Industrialization Housing: Measuring up. There are a variety of relatively informal measures by which it can be agreed that a particular economic activity is actually an industry in the contemporary

sense. These might include the size of the largest producers in terms of their relative share of the total market, the continuity of operations by producers through adverse economic periods (e g., staying power), the extent of product responsibility, and a sophistication of management and control.

By most of these standards, housing activity cannot today be described as industrialized; e.g., be termed an industry. However, the opposite view is hardly accurate. This view is often characterized by the popular saw that "a carpenter of 100 years ago, were he to emerge from a Rip Van Winkle-type sleep and appear on the conventional construction job-site with tools in hand, could go right to work without further instruction and no one would be the wiser." Insofar as one is speaking about Type V (light wood) frame construction, this might be true, as the "balloon frame" was born with the advent of the machine-cut nail some 100 years ago. But, that is where the analogy stops. Obviously, he would be totally foreign in the advent and building-in of all mechanical and electrical subsystems that we take for granted today, nor would he be familiar with the primarily dry finishing materials such as sheetrock, now in common use. More importantly, his handsaw was long ago replaced by a power skill saw, and even his hammer has lost out to air-driven nailers and staplers.

This while one who is confronted with studying the construction industry, or even more so, involved in its daily-often-frustration operations, is most tempted to say with Rudyard Kipling as he did in the early 1800's in his "A Truthful Song"....

> "I tell this tale which is strictly true,
> Just by way of convincing you,
> How very little since things were made,
> Things have changed in the building trades."

....it just is not so. For the production of housing, it cannot be considered industrialized, it most certainly has been "rationalized".

The Rationalization of Building. Rationalization is another way of saying that selected functional improvements have been made within the context (or constraints) of an existing system. As we have seen, the present mode of housing production is a delivery system (however, as inefficient as we may feel it) which responds in a holistic fashion to certain forces in its greater environment over which it has little control to meet its objectives. It is only within this context of the present system that rationalization can be understood and within which it is understood.

Even in its most conventional forms, the industry has been using off-the-shelf premanufactured parts, components, and even subassemblies for years. (After all, studs are not cut on the site, nor are bricks cast, wiring wound, or highly sophiscated mechanical, electrical, or conveyance systems manufactured or even assembled on the site. Premanufactured cabinetry and millwork are perhaps the best example.) Beyond that, improved processes of both management and production have been added to what essentially remains an on-site construction sequence.

In terms of the former, particularly where large-scale projects (housing developments) or very complex projects (high-rise buildings, hospitals, schools) are involved, the conventional construction industry scored a resounding first in its wholesale adoption and sophiscated adaptation of a management technique straight from the aerospace industry. But, the eager reception of Critical Path Management, Project Evaluation and Review Techniques and even PERT-Cost in the management of construction is easy to understand. One merely needs to consider the similar nature of an involved aerospace project and contract for, say, the Polaris submarine and missile and the complex construction and contract for a community hospital. Both involve the management of management itself as well as management of production process. A multitude of participants, consultants, and different organizations must receive coordinated directions as to the scope and timing of their design input as well as the required levels of the input. Similarly, the requisitioning of resources, products, components, and subassemblies must be interwoven into a careful scheduling of actions. This, in turn, must be coordinated with the bringing of highly paid skilled personnel onto the job at just the right time so that they will have work and the tools to do it, and then with an absolute minimum of waste. Over the entire process hangs both the promise of additional shared revenue of incentive clauses for beating delivery dates and agreed upon costs, and the threat of substantial liquidated damages or other penalties if those dates and costs are not met. The rationalization of construction, particularly of homebuilding, is in part an outgrowth of earlier prefabrication techniques. More than that, it is essentially the modernization and streamlining of individual operations in traditional building methods, but only as to the actual erection of the on-site building. In terms of production, rationalized construction still depends primarily upon the utilization of skilled labor on the site. However, it becomes a process which incorporates much of the innovation and a number of prefabricated components. While this has occurred at all levels and in all types of construction, it has reached its highest development, at least in this country in the production of primarily single family housing developments and tracts.

Traditional building begins to utilize limited industrialized construction techniques in a significant way whenever the private enterprise builder has become large enough to integrate (and control?) the processes of land assembly, subdivision and servicing of that land, as well as design, manufacturing, purchasing, transport, construction, and sales.

Most large homebuilders are in this category. Utilization of all varieties of hand power tools (saws, planes, nailers, and staplers) and materials handling equipment is everywhere in evidence on their sites. The prefabrication techniques they use may occur on the site or at some location away from but convenient to the houses being built; alternatively, they may occur in a small factory nearby. These techniques most often apply primarily to the building shell.

They may be in the form of single components such as prenailed stud walls or sandwich wall panels, or they may be in the form of the precut house which is cut on site, in the nearby factory or even bought on the open market, which contains all wood parts cut to proper lengths and shapes and color-coded as required to frame and enclose the house. They almost always include items such as preframed and nailed roof trusses and prehung doors in frames. Also purchased off the shelf are packaged heating systems, unit air-conditioners, and prewired panel boxes which eliminate costly, time-consuming on-site mechanical operations and are at the same time generally accepted by local labor, building codes, and users. But, those builders continue to use local, on-site skilled labor for installation, connection, and conventional finishing techniques to establish local contacts and to provide a modicum of flexibility. Thus, they limit their use of purchased components, industrial prefabrication, and their own on-site or shop prefabrication to those areas in which these products and techniques can make the most significant improvements within their particular scheme of things; e.g., within the existing system.

Levitt and Sons' Eastern single-family home operations are an example of one configuration of this approach. In a 19-acre warehouse in Delance, New Jersey, Levitt receives most raw materials for a specific housing project, including prefabricated roof trusses and some precut lumber. A 125-man staff packages and makes all items for a specific house in a given project. Then, according to a carefully prearranged timetable, each package is drop-shipped to its proper building pad. Levitt does not operate a mechanical production line or prefabrication plant for off-site production of building components to be used in their single-family detached home projects. However, in many projects, Levitt carpentery build stud walls

on the ground and tilt them into place (this actually being typical of the most conventional kind of house construction).

Bender has described this level of building system as an assembly of independent, noncompatible subsystems. Within each subsystem, problems are carefully solved [IV-20]. But, they are solved only with regard to that subsystem. The final assembly therefore may reflect their varied sources, on- or off-the-shelf; e.g., their interfaces. Holes required to be cut in structure or through finished surfaces, exposed pipes or wires, differential expansion at joints, and colors that do not match are often the result. It should be noted that as we have taken a first step down the line from conventional construction, the kinds of tradeoffs involved in industrialization processes have become immediately operative. To make even the most elemental kinds of prefabrication or component purchase possible, the designer must attempt to utilize the maximum amount of stock or standardized components by minimizing the variety in component shapes and sizes. In the aggregate, the tract is filled with limited range of models, each being capable of extremely limited and generally not too significant variation.

Even at this limited (all be it, in a systems sense, reasonable) level of industrialization, the conflict between desired variety and the requirement for maximum standardization necessary to maximize the benefits of even this first level of industrialized construction now begins to appear. The question of standardization is one about which the many fears of industrialization tend to revolve. Looking ahead towards a more extensive process of industrialization, if one takes the European model, there is relatively little to allay these fears. As many people have observed, the degree of total standardization (i.e., in this sense the lack of variety between living units or as the Europeans call it "individuation") varies from very little in westernmost Europe and increases as one travels east to the total uniformity of the Russian model approach.

The Swedish Industries Building Group's belief in competition as a guard against sterility and monotony is little allayed by the incessant concern for standardization. However, standardization can have many meanings. As P. E. Malmstrm [IV-21], the widely acknowledged "father" of industrialized housing processes in Europe has said, "each country must find its own compromise between the most efficient scheme of construction (all flats identical) and a certain flexibility, allowing individuals the flat they want personally and giving residential areas a district character."

Thus, insights as to how standardization might apply to the housing process in this country can be achieved only through an understanding of how innovation operates within its free enterprise of markets.

Technological Innovation, Management, and the Marketplace — Many Paths to Industrialization. In considering the market place, there is a fundamental difference between need and effective demand. The first is well recognized; it is what the housing crisis is all about. The second refers to the ability to translate that need into the actual ability to contract and pay for housing — that is currently "where the action is." The diverse public and private efforts to increase effective demand has begun to reconfigure the market. As Colin Davidson [IV-22] of Washington University, St. Louis, pointed out at the first annual Industrialized Building Exposition and Congress held in Louisville, Kentucky, last year (and known then as IBEC-70), "the industry responds to effective demand only. When there is a change in the market place, industry responds by innovating. The nature of that response or innovation will be a reflection of the role played by the innovator in the industry. Thus, innovation always favors its sponsor first while others benefit indirectly."

The level of innovative thinking about housing and its process of industrialized production was occasionally relatively high in formal presentations at the IBEC Conference. The level of innovation in products and equipment displayed on IBEC's exhibition floor was almost uniformly low. What innovation was, in evidence, had to do primarily with subcomponents and production equipment. Innovation in terms of the former was in the sense not of new developments, but of developments long proposed and not finally enjoying the commitment of capital. They included prefabricated plumbing walls and preassembled fiberglass bath components and assembled from two or more half-shell molded sections. Innovative production equipment centered on tape-controlled and even computer-directed cutoff saws and multipositioned quadri-saws and nailers capable of cutting and/or nailing up walls and trusses. Yet, this sophisticated production equipment still worked with wood studs. Its manufacturers clearly perceived that their market, while changing, was still made up of "stick-builders." Their machinery was, accordingly, developed to work wood, albeit in an infinitely faster and more accurate fashion.

As John Berhard [IV-23], Dean of the School of Architecture and Urban Design, State University of New York at Buffalo observed at IBEC, "the gang-nailers and cutters on the exhibition floor do what carpenters did 100 years ago with saws and hammers. The industrial machines at the exposition do not really advance technology (of building)."

He acknowledged that the machine manufacturers know how to make their products well. But, he called for machines that would be based on the production of new kinds of components with new kinds of materials.

In light of the preceding remark on the perception of market, it is clear that Dean Eberhard was not addressing himself to the real question — that of implementation. As has been pointed out, the traditional industry is a system. More than that, it is a well-understood and well-established system which has evolved through experience over the years (regardless of how one feels about its present capabilities). It is supported by a wide spread, intricate network of material suppliers, interim financing and supplier credit arrangements, functionally differentiated contractors and subcontractors, labor-flows, etc., resulting in a system with a built-in flexibility suited to the presently localized nature of housing markets. As such, it is an organization which has thus far, however imperfectly, been able to move its products into the hands of the consumer. True enough, that system may appear to becoming increasingly inefficient, especially when compared to other more highly capitalized industrial systems. But, as Mr. John M. Dickerman pointed out at IBEC, any new system, to compete effectively with the established traditional system, must be able to overcome any competitive disadvantages inherent in that new system. Simultaneously, that new system must provide as good or better service, cost benefits, and/or product and product quality [IV-24].

It is therefore of little use to lament particular levels of technological innovation within the industry, "out-of-hand." Its participants and/or components must be shown clear advantage for specific change from the existing if implementation is to occur. Thus, whether we are talking about the developer, builder, supplier, and manufacturer, he must be shown a market that fits within his objectives.

In terms of technology levels, Professor Davidson pointed out that traditional technology exactly corresponds to the way in which the traditional building industry is organized; the roles people and institutions play, the kinds of information they exchange, and the tasks they perform. To introduce a new technology implies changing this traditional organization [IV-25].

For example, one way of achieving one or more of the goals of costs, quality, or time is to combine technological innovations in a way that, in the aggregate, shows significant improvement. But, this in turn most often implies greater control and responsibility; i.e., commitment by the

innovator. Thus, to say to the machinery manufacturer at IBEC that he should build machinery which will work with new materials in new ways without indicating a market for such machines is really to suggest that he develop and market the new materials and techniques himself; then he is no longer merely a maker of machinery. He may have to become a manufacturer of building subcomponents, an installer, and perhaps even a developer or builder. If we see that is necessary, we must be able to show him why it is to his best interest to increase his level of commitment and responsibility.

The changes in traditional roles within the construction industry that are both directly evident and indirectly implied were discussed throughout the IBEC Conference and have been often referred to in the literature.

For example, as Frank Whitney, President of Walter Kidde Constructors, Inc., has pointed out, with industrialization (not only) will the builder's function be reoriented. To survive he must participate actively in the transition of building practices. His traditional on-site role will decrease and his off-site role will increase. On-site, he will become more of an erector. Off-site, more emphasis will be placed upon his ability to control costs. He will have to work with CPM and other computer techniques to better schedule, purchase, and expedite. In short, he will cease to become an assembler or pieceworker and will emerge as a professional manager.

In addition, the builder will become more involved in the design process and will also become involved with factory processes themselves. This is but one force toward the dissolution of the traditional industry separation of the roles of creating, financing, contracting, designing, producing, installing, and operating housing [IV-26].

Professor Davidson [IV-27] was also succinct in his reference to management organization. He stated that successful industrialization depends on development of an organization exactly attuned to its technology and its industry environment. The design of this organization is often more difficult than the development of new techniques.

The absence of certain other kinds of roles and functions in construction that typify other industries has been described by Bernard Weissbound, president of the development firm Metropolitan Structures, Inc. He pointed to the fact that even the most elementary research tools are missing from the construction industry, including the absence of an adequate library or even the most rudimentary information processing and

dissemination system. He felt that Operation Breakthrough would be able to help a great deal in the area of research and development.

It should be clear that organizational changes have repercussions far beyond the specific tasks of using industrialized building methods in manufacturing the product. They affect every aspect of a chosen mode of housing production.

This is the reality of Professor Davidson's observation that industrialization really involves the processes we use. If one considers the traditional formula of resources + process = product, then the real advantages necessarily arise from a better use of resources in better ways. Successful industrialization can therefore be seen as stemming from well-managed and well-coordinated processes.

In turn, Ezra Ehrenkrantz has related resources to needs as being the key to any systematic attack on the problems of housing facing us. What must be considered is the method of allocating funds, establishing of goals, understanding of what the resources are that are available, and the use of those resources in the best possible way. He lists those resources as land, finance, management, technology, and labor. The crucial problem is development of overall management capability to most effectively utilize the resources available.

In a sense, the previous remarks tend to point toward the European concepts of total product responsibility with which this section opened. The key difference has to do with the market. The market is but another way of identifying the user. A significant situation in this context is the differentiation of the market and the rise of consumerism that is occurring in this country. When developers and the government come to more fully realize that these two forces will create specific demands in the market place, different kinds of environments with differing levels of amenity and quality will, many believe, be perceived as necessary alternatives to the countless variations on the standard garden-variety tract house now available to the consumer. This would seem to be the basis behind the maximazation-of-alternatives concerns being expressed in this program. In these trends, an increased potential for new technology may be seen, not only in housing but in the entire construction industry as well. Mere quantity provided under crisis conditions may be insufficient. Thus, the philosophical basis for industrialization seen in Europe and developed in this report must be viewed through the filters of our own national political, economic, and sociological value systems as expressed in the market in order for some of its attendent problems such

as standardization to be understood in the context of industrializing the American housing industry.

Industrialization and Quality Environments. The Soviet Union, because of the form of its government and the control by that government of all sectors of the nation's activity, was able to define in its own terms the nature of the very-real housing crisis it faced following World War II. For the same reasons, it was able to set out a very few, extremely direct solutions to the problem. What resulted was the development of a high degree of industrialized building technology (far surpassing that of the Western World at the same point in time). That technology has been capable of producing housing of a particular kind in large volume and at a very high rate of speed. The practical result of that capability explains the mile upon mile of identical housing blocks ringing Moscow and other major Russian cities; i.e., housing projects that have provided gist for criticism at one time or another for every major architectural or social critic.

More significantly, the Soviet Union has only recently recognized in its solution: needs for a failure of intent in terms of its own national goals. If those goals are to outstrip the West in terms of advanced technology or merely to adequately meet the needs of its own population at home, the Soviet Union has recognized the need for capable people engaged in creative, innovative approaches to the problems at hand. It has further recognized that the kinds of living environments inherent in its housing solutions are at least less conducive than might be possible in fostering the kinds of creativity and innovation it sees as necessary. The Soviet Union has rather belatedly begun to do something about the new, secondary problem that it has created in its approaches to its initial dilemma of housing.

By comparison, the diversity of American society will fortunately preclude this kind of single solution to its own housing problems. This may be the real meaning behind the kinds of generalized, often vague pronouncements with which one is always confronted in the literature of industrialized housing. To quote but two:

> "No amount of stylistic trickery is going to change the mass nature of housing. The problem is to use the machine as a tool guided by human values to give variety between building, flexibility and spaciousness within the dwelling unit, and a series of forms that have an excitement and expressiveness growing out of their new precision and lightness [IV-28]. (...and, one would add, growing out of the needs which brought about the solution as well as out of the means selected to create and produce that solution)."

Secondly:

> "...we are in this country affluent enough that, as a people, we will not accept second hand, trumped-up solutions to the problems these needs (of housing, building, and related requisite urban service systems) will generate. This same affluence will guard us against sterilization of building [IV-29]."

This then is the import of a remark made by Professor Cibrini [IV-30], one of the contributors to the initial definitions of industrialization stated herein, when he stated that: "The overall goal is one of inproving productivity in terms of output per man-hour and output per capital dollar expended without sacrificing quality in the buildings so produced.

Assuredly, there have been many suggestions advanced that present quality standards of housing in this country be relaxed so that we might more easily achieve our quantitative goals. Lacking any clear decisionmaking mechanism capable of displaying the implications of alternative directions to be taken, the present crisis environment (real or manufactured) may cause us to choose that course of action. The fact that countless hundreds of industrially produced housing units built in West Germany under "crisis criteria" immediately following World War II now lie vacant because of changing social values even in the face of a continuing housing shortage infinitely more severe than our own will likely not deter us, as this situation is not generally known. Even the growing awareness in this country that the low-income conventionally constructed housing units now being built to perhaps the most minimal standards possibly may become new slums long before the government's 40-year responsibility for interest subsidy has been discharged may still not disuade us.

Quality has infinitely greater meanings than building with expensive materials. It implies meeting not only present but future changing needs of immediate as well as successive users. It is for this reason that the Auburn Design Program considered the design of a "variable alternatives living unit model" as one alternative choice for its summer topic. As outlined in the appendix, the design of such a model implies standardization for industrialized production in a much broader context than, for instance, "the largest box that will fit on the highway." As Carl Koch [IV-31], innovative-designer of Tech-built Home and the Techcrete Building System, has stated: "The real challenge is to design for standardization and mass production in a way that will provide more choice, more beauty, and more freedom — not less." Equally important is Koch's admonishment that one cannot overemphasize initial cost against long-term considerations of maintenance, enjoyment, satisfaction and more and more important as it daily accelerates, cultural and social change.

The concept of quality is admittedly most elusive. It should be clear, in any event, that the scope and complexity of the problem will preclude not only single or best solutions, but will also work to limit industry-wide agreement as to definition and methods. Some type of cooperative interaction between all those involved in producing the built environment will be required at some level basic enough to allow a series of continuums of operation for production in the market. Beyond that, each element can agree to disagree. The degree to which any organization pursues cooperation beyond this level can then be a function of that organization's perception of the situation. Then, within the confines of its own policyenvironment and view of the world, it can evaluate what it perceives to be the most valid set of figures that, in turn, for it, lead to the most conclusive and promising solution sets; e.g., courses of action. The same types of organizational characteristics will determine the extent to which that organization subscribes to the pronouncements made in the two previous quotations which are, after all, evaluations of the market. Successful competition for what will continue to be limited resources at whatever scale of commitment within the richness and diversity of the housing problem will call for creativity and innovation of the highest order. The results of diversity and richness can only be to the nation's gain.

In the end, the lateness with which the construction industry has come to the realization of industrialization may actually be the proverbial "blessing in disguise." We possess an opportunity to make a quantum jump in the solution of our built-environment needs. Whether that jump will be forward or backward remains to be seen. As Mr. Joseph E. Dennis of Operation Breakthrough winning Townland Marketing Corporation observed at IBEC: "This new industry of ours is capable of perpetrating an environmental disaster." But, that result need not be negative. In neatly postulating the alternatives, the following remarks by Mr. Dennis [IV-32] provide an appropriate conclusion to this section of this report:

> "During the next 5 to 10 years, the industrialized building industry, if we let it, could grow into a very fierce, simple-minded idiot monster who, gorged on plastics, plywood, and concrete, will go rampaging over our countryside vomiting up monotonous modular piles of ticky-tacky boxes in which he will then force us all to live."

"On the other hand, if we have the wit to make it happen, this new industry with its promises of economies of scale, scientific production and management techniques, and new materials could be a means of reversing our country's drift towards physical squalor. This will eventually make it possible for millions of us to enjoy a better environment than any that has been known before."

Housing Information, Data, and Predictions. Data and information are essential to any decisionmaking mechanism in a modern society. Their function in housing is designated in Chapter III where they are included as requirements for the Management Institutions Model. At present, the basic data of housing are collected and analyzed by many sources and agencies. The basic and most prolific source of demographic data is the Bureau of Census. Statistics on employment and earnings are available from the Bureau of Labor Statistics, and HUD regularly publishes data on all aspects of housing including sales, social characteristics of residents, and financing. Facts relating to construction and professional activities are available from the American Institute of Architects and the National Association of Home Builders. Data on local needs usually can be obtained from the corresponding municipal and county governments and local chambers of commerce. Other agencies such as Department of Transportation, HEW, Office of Management and Budget, Office of Economic Opportunity, Department of Agriculture, and the Office of Civil Defense generate information relevant to housing analysis.

Though the sources of data on housing are numerous, data are still sufficient for many applications, and analysts must resort to the time-honored art of guestimation. There is a lack of adequate data on housing condition, tenure of new housing, units lost in disasters, and rent-budget allocation of households. The great number of data sources also leads to a lack of standardization of data form and a lack of coordination of effort. This also introduces inconsistencies and inaccuracies.

To analyze the state of housing, project housing needs, and evaluate housing programs and policies, data are needed on population characteristics, site characteristics, community characteristics, housing conditions, tenure-ownership relationships and codes, standards, and building restrictions. To implement the construction and design aspect of a housing program, additional data and information are needed on the state of the art of the industry, the types of building materials available, the various firms which

are capable of producing what type of unit, available financing, and labor attitudes, skills, and policies. A clarification of these points can be made by an examination of the national housing goals for the decade 1968-1978.

Analysis of Housing Needs for Decade 1968-1978. A declared national housing goal is that the nation will need 26 million units during the period 1968-1978. Two other figures, which also give an indication of the housing situation in the U.S., are that 7.8 million households cannot afford adequate (standard) housing in 1968 and that 6.1 million households live in crowded conditions in 1968. The principal source of data for analyzing the housing needs for the decade 1968-1978 was the 1960 U.S. census. These data were analyzed to determine various 1960 housing characteristics (substandard housing, crowding, income distribution, etc.) and these characteristics were then projected to the base year, 1968, and again to final year, 1978. The decade housing needs were determined by comparing the 1968-1978 projections.

The 26 Million Units — The 26 million unit figure was derived by General Electric's TEMPO [IV-33]. In gross terms, this 26 million units consists of 18 million new units and 8.7 million substandard units which must be replaced or rehabilitated. A further breakdown of each category can be obtained by examining Figure IV-1. There have been other predictions of housing needs. These are compared in Table IV-2. One can see that though the total figures are comparable, there is a significant variation in each category. By arbitrarily listing the maximum and minimum value in each category in the last two rows of Table IV-2, a total number of needed units between 35 million and 20 million could have been derived.

New Households. The TEMPO 13.4 million new household formations for the decade 1968-1978 is the Series I-B U. S. Census Bureau Projection [IV-37]. This projection is based on two assumptions: (1) Migration rates will continue within the range observed in 1955-1960 and 1960-1965; and (2) a moderate increase in national fertility for present levels. These assumptions lead to maximum housing needs and greatest local housing demands. Series II projection makes opposite assumptions and Gladstone [IV-34] used these projections to arrive at 11.6 million new households.

Net Removals. Net removals are the units taken out of the housing inventory because of demolition, fire, conversion, mergers, etc. TEMPO calculates net removals by subtracting the change in total number of housing units from the number of housing starts. The average net removal rate of all classes of units during the decade 1950-1960 was 330 000 units/year and for

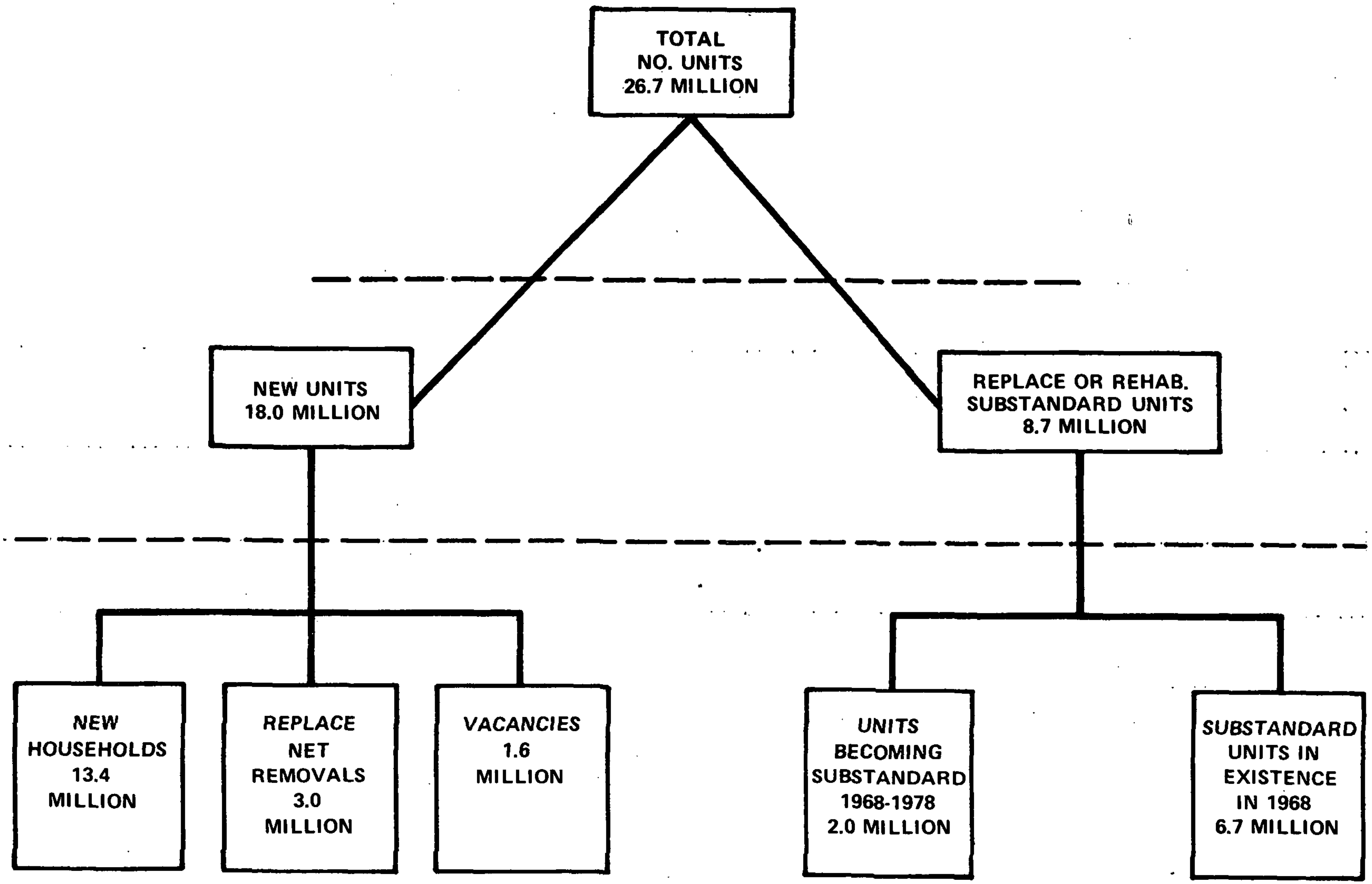


Figure IV-1. Housing needs — 1968-1978.

TABLE IV-2. COMPARISON OF VARIOUS HOUSING NEEDS PREDICTIONS FOR 1968-1978
(HOUSING UNITS IN MILLIONS)

	New Households	Replace Net Removals	Vacancies	Units Becoming Substandard	Substandard Units Existing	Mobile Home Replacement	Population Shifts	Total
G.E. Tempo	13.4	3.0	1.6	2.0	6.7	-	-	26.7
Gladstone	11.6	4.9	1.7					
U.S. Congress (1967)[IV-35]	13.1	2.0	4.4	2.0	5.7		1.0	28.2
U.S. Congress (1968)[IV-35]	13.5	2.0	3.5	3.5	4.5	1.2	-	28.2
Maximum	13.5	4.9[b]	4.4	3.5	6.7	1.2	1.0	35.2
Minimum	10.0[a]	2.0	1.6	2.0	4.5	-	-	20.1

a. It seems that Gladstone did not subtract out substandard units; however, Somichrast has predicted a removal rate of 700 000 units/year (1)

b. Approximate Series K forecast of U.S. Census Bureau [IV-36, IV-37]

for the years 1960-1965, this removal rate was 490 000 units/year. For purposes of the 1968-1978 prediction, TEMPO assumes a removal rate of 0.5 million units per year or a total of 5 million net removals for the decade 1968-1978. A part of these units will be substandard.

Substandard Units. A unit is substandard if it lacks running hot water or if it is dilapidated. An evaluation by the U. S. Census Bureau of the 1960 Census has shown that the data on the condition of housing units were both unreliable and inaccurate, perhaps by as much as one-third in the case of dilapidated units. The 1968 housing goals call for the removal of all substandard housing. In 1960, there were 9 million substandard units in use. TEMPO predicts that by 1966 this was reduced to 6.7 million units [an OEO survey in 1966 shows 5.7 (Table IV-3)].

TABLE IV-3. CHANGE IN NUMBER OF SUBSTANDARD UNITS

Period	Net Removals (million)	Net Flow to Standard Due to Repairs and Deterioration (million)
1950-1960	2.8	4.6
1960-1966	1.08[a]	1.2[b]
1967-1978	1.98[a]	2.4[b]

a. Seems to be calculated at a flat rate of 180 000 units per year as compared with a rate of 280 000 units per year for the previous decade.

b. Seems to be calculated at an approximate rate of 200 000 units per year as compared with a rate of 460 000 units per year for previous decade.

Noneffective Demand Households. Those households which are unable to obtain standard housing in the market unless they allocate in excess of specified portion of their income to housing are called noneffective demand households. An estimate of these households is obtained by comparing a rent profile of standard units with an income profile of households. A key part to this analysis is an ability to pay criterium. This is

stated in terms of a percentage of income which should be allocated to housing. The national average is 15 percent; however, this varies from 35 percent for those earning less than $ 2000 to 10 percent for those earning $ 10 000 (1960 dollars). TEMPO assumed 20 percent which is what a family earning $ 4000 to $ 5000 allots. Gladstone used 25 percent which is what one must allocate to qualify for subsidized housing. How these assumptions affect the number of noneffective demand households can be seen by examining Table IV-4.

TABLE IV-4. NONEFFECTIVE DEMAND HOUSEHOLDS LIVING IN URBAN AREAS AS A FUNCTION OF PERCENTAGE OF INCOME ALLOTTED TO HOUSING IN 1960

	Percentage of Income (%)	No. of Households (Millions)		
		White	Nonwhite	Total
National Average	15	6.0	1.6	7.6
G. E. Tempo	20	3.8	1.0	4.8
Gladstone	25	2.4	0.7	3.1

Though we have used the national sense as our illustration, similar comments are valid on all levels of application. It can be noted in the above example that a lack of certain theoretical knowledge or a lack of a suitable definition at times exists. Just what is an acceptable ability-to-pay criteria for low-income households is not understood and can lead to a significant variation in the number of noneffective demand households. The definition of substandard housing is minimal and does not take into account kitchen facilities, undersized rooms, low ceilings, inadequate heating and ventilation, and insufficient lighting. Furthermore, it is not clear that demographic data such as family size, income, age, ethnic characters in a reliable way determine the needs of a household.

Currently, HUD has granted several contracts to design and develop protypical urban information systems. The implementation of such systems should greatly ease the data problem on the municipal level; however, these systems are designed for municipal administrative tasks and do not include data on housing per se. Such data should be added to such systems.

The situation with technical data and information is worse. Much of this information is of a proprietary nature and industry is usually reluctant to release it. Though HUD has recently published several works on the housing industry, such documentation is not yet complete and much is left to be done, especially on comparison and evaluation of the various technologies involved.

There are few American technological or scientific journals directed to the field of housing, housing construction, and housing design. An adequate abstracting service does not exist for collecting and organizing articles that appear on housing in other scientific journals. American universities have few programs directed to housing and have trained few housing specialists. In short, there is an absence of a scientific tradition and scientific literature of a recognized profession in housing [IV-38]. In such an atmosphere, technology advances slowly, innovations come spasmodically, and there is little hope for improvements.

System Modeling. Modeling has long been used in the technological fields where it may be termed simulation. The development of models or the simulation of physical systems is necessitated by the quantitative (numerical) information necessary for the development of physical systems and by the complexity of many physical systems.

For the same reasons, complexity and the need for quantitative information, it has become necessary to simulate the social or soft systems. The simulation of social systems is further complicated by their statistical nature; i.e., they do not always behave in the same fashion even though influenced by what would appear to be the same set of circumstances. The amount, availability, and reliability of data concerning social systems often place a limitation on the simulation of these systems. Despite these difficulties, there are many instances in which models of social systems could provide guidelines for policy decisions and in some instances quite reliable hard (numerical) data.

A brief review of simulation of social systems, their development and applications appears in Appendix B. Although this review is not complete, it should serve as a basis through which the reader can find other information concerning social systems modeling.

Conclusions

1. An engineering design of building materials is dependent upon and interrelated with an engineering design of living units. Materials and living units should be designed to meet acceptable performance criteria. The state of the art of the housing industry and a lack of understanding of suitable criteria inhibits this coordinated design. The fragmented nature of the home construction industry makes it unlikely that a coherent attack on the problem will come from there. Therefore, an organization such as NASA, which has experience in the systems design of operational units and their attendant fabrication, could make contributions in the systems design of housing.

2. There is an absence of scientific tradition, scientific literature, and a recognized profession in housing. Its technology, therefore, advances slowly, innovations come spasmodically, and there is little hope for improvement.

3. Financial support should be provided to such activities to permit a systematic adoption of performance criteria in present building codes. This activity will encompass gathering, processing, and providing scientific data in the users needs and performance concept areas. This data bank will assure that local authorities are appropriately equipped with sound technical information that will assist them in upgrading their codes to a more uniform basis throughout the country.

4. The housing industry should be encouraged by whatever means possible to assist the National Conference of States on Building Codes and Standards in its endeavors.

5. Government agencies, federal, state, and local, should cooperate in introducing and promoting new technological innovations and inventions that meet the users needs of low-income housing in their own housing programs. Feedback and evaluations of these programs will provide hard data that will assist in the evolution of the performance concept. In addition, government housing programs will create the size market needed to justify the high initial cost in introducing new innovation and inventions in the housing field.

6. The lateness with which the housing construction industry has come to the realization of industrialization may be a proverbial "blessing in disguise." It possesses an opportunity to make a quantum jump in the

solution of our built environment needs. Whether that jump will be backward, covering our countryside with monotonous piles of boxes, or forward, reversing our country's drift toward physical squalor, remains to be seen. We have the opportunity to provide an environment better than any envisaged thus far.

REFERENCES

IV- 1. In-Cities Experimental Housing Research and Development Project, National Bureau of Standards, March 1969.

IV- 2. The National Conference of States and Building Codes and Standards, Constitution and Bylaws. National Bureau of Standards, U. S. Department of Commerce.

IV- 3. Eberhard, John P.: The Performance Concept: A Study of its Application to Housing. National Bureau of Standards, Washington, D. C., PB 184-458, 1969.

IV- 4. From a presentation by Mr. Charles M. Mahaffey, Building Research Division, National Bureau of Standards, Washington, D.C.

IV- 5. Congressional Record, 92nd Congress, First Session, vol. 117, no. 70, Washington, D.C.

IV- 6. Building Codes. The Center of Environmental Studies of the Polytechnic Institute of Brooklyn, January 1971.

IV- 7. Rutgers, Norman L.: How HVAC Systems Fit Factory Production. Lennox Industries, Inc., IBEC/70.

IV- 8. Smith, H. C.: Integrating Mechanical Subsystems into Industrialized Housing. Westinghouse Electric Corporation, IBEC/70.

IV- 9. Phase I Composite Report, Volume III-Technolgoy. Department of Housing and Urban Development, March 1969.

IV-10. Flat Conductor Cable Design, Manufacture, and Installation. NASA TM X-53975, September 1968.

IV-11. The Swedish Industries Building Study Group: The New Market. Stockholm, Sweden, 1969, pp. 15-16.

IV-12. Bender, Richard: Selected Technological Aspects of the American Building Industry - the Industrialization of Building . Prepared for the National Commission on Urban Problems, 1969, p. 1.

REFERENCES (Continued)

IV-13. Mayer, Lawrence A.: The Housing Shortage Goes Critical. Fortune, December 1969, p. 89.

IV-14. Ibid., p. 88.

IV-15. Ibid., p. 89.

IV-16. Building Blocks for Profit; Modular Housing, Birth of an Industry. Outlook, p. 787.

IV-17. Mayor, op. cit., p. 89.

IV-18. Housing. Time Magazine, November 15, 1968, p. 67.

IV-19. Part IV, The Housing Enigma. Production, June 1970.

IV-20. Bender, op. cit., p. 28.

IV-21. Malmstrm, P. E., and Munich-Peterson, John F.: Philosophy of Design and Adaptation to Production in Industrialized Housing. United Nations Seminar on Prefabrication of Houses in Latin America, Ministry of Housing, Copenhagen, Denmark, 1967, p. 6.

IV-22. Presentation by Colin Davidson: What We Can Learn From the European Experience. IBEC/70.

IV-23. Presentation by Dean John P. Eberhard: New Roles for Professional Designers. IBEC/70.

IV-24. Moderators remarks by Mr. John M. Dickerman: Greater Opportunities Through New Techniques. IBEC/70.

IV-25. Davidson, op. cit.

IV-26. Whitney, Frank: Industrialization and the Builder. Presentation at the Harvard/National Urban Coalition Conference on Housing, Mass Industrialization, May 8, 1970, Cambridge, Massachusetts.

IV-27. Davidson, op. cit.

REFERENCES (Concluded)

IV-28. Dudar, Helen: Mobile Architecture. Progressive Architecture, June 1968, p. 134.

IV-29. Gaysor, Richard P.: The Need for an Organized Building Process. Presentation at the annual meeting of the American Society of Civil Engineers, September 30 - October 4, 1968.

IV-30. Dawson, John A.: A Survey of the State of the Art - 1969. The Specifier, August 1969.

IV-31. Koch, Carl: Component Design for the Urban Environment. Building Research, January/March 1968, p. 13.

IV-32. Presentation by Joseph Dennis: Assembling a Multi-Disciplinary Town.

IV-33. United States Housing Needs, 1968-1978. The Report of the President's Committee on Urban Housing, Technical Studies, vol. I, (Prepared by G. E. TEMPO).

IV-34. The Outlook for United States Housing Needs. The Report of the President's Committee on Urban Housing, Technical Studies, vol. I (Prepared by R. Gladstone and Associates).

IV-35. Cooper, James R.: Can the 1968-1978 National Housing Goals Be Achieved? Committee on Housing Research and Development, University of Illinois at Urbana - Campaign, 1971.

IV-36. Kristof, Frank S.: Urban Housing Needs Through the 1980's; an Analysis and Projection. Prepared for the National Commission on Urban Problem, Research Report No. 10.

IV-37. Population Estimates. Series P-25, No. 394. Bureau of the Census, June 6, 1968.

IV-38. Simpson, James R.: Better Housing for the Future. A Report to the Panel on Civilian Technology, Office of Science and Technology, Executive Office of the President, April 1963.

CHAPTER V.

MANAGEMENT, ECONOMIC, LEGAL, AND POLITICAL CONSIDERATIONS

CHAPTER V. MANAGEMENT, ECONOMIC, LEGAL, AND POLITICAL CONSIDERATIONS

Introduction

When the task group embarked on the design experience, very few people thought that considerations such as management, economic, legal, and political would be the "rust on the gears" of the housing mechanism. However, it has become apparent that these items affect the housing situation in significant ways.

The real problem is the housing industry is not the lack of "hard technology," but rather the more vague and often ignored "soft technology." In fact, it is in this soft technology area that the aerospace industry has also been so successful. Some of the applicable areas are quality control, standards enforcement, communication in the broad sense, and systems management.

The general areas of concern that are considered in this chapter are:

1. Land-use processes.

2. Financial mechanism.

3. Government policy.

In this chapter, emphasis is placed on land use processes. A detailed description of the financial mechanism is given in Chapter VIII.

Land-Use Considerations

Availability of Land

- As an input to the land-use intra-action block, the availability of land is a critical element.

- As our population grows, it must be determined whether there is enough land to house, feed, and provide industry for the amenities in life.

- As the Kaiser reference report comments, there is much land in the United States. For example, all 200 million Americans could be housed in single family homes in an area roughly the size of the state of Iowa [V-1].

Also from an editorial "Urban Growth" in American City, November 1963, urban areas have been growing at about 2 percent annually [V-2]. Since urban areas occupy 1 percent of the total land area of the continental states and if the trend continues for 50 years, there would be a 100-percent increase in urbanization; i.e., in 50 years the urban areas will occupy approximately 2 percent of the land area. Note, of course, that a doubling effect is taking place and, hence, adequate planning must be made now to avoid complete urbanization. Also, it is not known precisely how much land is required to supply the needs of each man; it is also mentioned that urban highways take about 1.5 percent of the total land area but are growing only 20 percent as fast as urban areas, and, contrary to popular thought, the switch from horses to cars has actually increased the available land. For example, in 1910-1920 (end of horse-drawn era), the nation used 27 percent of its harvested area (15 percent of the total land area) to produce food for horses and mules, not including land for grazing. Hence, we see that the land requirements for transportation have dropped to one-tenth (15 percent to 1.5 percent), despite the population growth. It is estimated that the motor vehicles actually require about one-fourth of the land required by animals; however, the car and truck need the land where the competition (and hence cost) of the land is the greatest.

In regard to airports, it is suggested that the land needed for airports roughly balances the land made available as the railroads abandon trackage.

The cities use a smaller percentage of their developed region for residential purposes as they grow. Cities of 18 000 devote approximately 50 percent to residential use while cities of over 1 million devote only about 25 percent to residential use. As the cities grow larger, they devote less area to single-family dwellings. Thus, the relative area devoted to multi-family houses gains as urban areas grow.

There is also a relation between the number of families in a dwelling unit and the cost of public services required (or desired), but this is very dependent of the way in which the economic-political unit operates. Under enlightened planning and administrating policies, the multifamily home can provide good housing and bring in a tax revenue that is greater than the cost of municipal services [V-2].

Land Costs. The classic rule, 20 years ago, of 10 percent for the price of lot to building value became obsolete. Currently, the total cost related to the land has increased to an average of 18 percent as a minimum in a metropolitan area. For higher priced houses, it is common to find the cost of land is even greater than 25 percent of the total house cost.

Once earlier, the price of lots with respect to the price of raw land was four to one with the profit going to the subdivider. Currently, as land prices rise, development density is increased, thus more units are developed on an acre of land.

The value given to raw land is because of its location within the sphere of development activity and, additionally, to the anticipation of future markets.

The price of raw land that is suitable for subdivision has increased more than even the high cost of preparing the raw land for building. Hence, in conclusion, the prices of improved lots have started a long term rise, the average cost of raw land increased an average of 14.5 percent per year in the 5 years (1959 to 1964), and at the same time, the price of lots increased 16 percent per year.

The Real Estate Desk Book cites some useful rules used by developers that reflect the cost distribution of developing land [V-3].

The "rule of 5" for subdivisions helps determine subdivision costs as follows:

1. Land cost, 20 percent.

2. Risk factor, 40 percent — administrative costs, advertising, sales commission, cushion, and profit.

3. Improvements, 20 percent — engineering, legal fees, utilities, and street surfacing.

4. Miscellaneous, 20 percent — interest, carrying charges, and carrying unsold lots after the 3- to 10-year objective liquidating period.

An example of how raw land value and lot price might be determined is as follows:

With a 2-acre tract, and lot size of 100 ft by 120 ft, the lot yield is 3 tracks per acre with other land used for streets. The improvement and expected costs are: water mains, $ 1200 per acre; sanitary sewer, $ 1350 per acre; street grading and pavement, $ 1050 per acre; curbs and gutters, $ 655 per acre; survey, legal, sales, and miscellaneous, $ 750 per acre. This yields a total cost, without land and profit of $ 4800, equivalent to $ 1600 per lot. If the developer wants to make $ 300 per lot and he can sell the lots for $ 2400 each, there is $ 800 per lot for profit and land cost. The land could, therefore, cost $ 500 per lot or $ 1500 per acre.

Public policy, such as the installation of facilities (sewers, schools, and throughfare streets) and the zoning of land, can influence in a marked way the cost of land. There has not been extensive study of these interactions with land costs.

Housing Standards — Building and Housing Codes [V-4]. Housing standards are normally defined by two types of codes: building and housing. In general, building codes deal with construction standards and housing codes with use and occupancy standards. Building codes specify such items as allowable stresses in various materials and design loads. As one might expect, there are more "hard" data in the area of building codes than there are about a decent home and a suitable living environment, the area of interest in housing codes.

When the standards that a code deals with become more subjective and less objective, and since codes are generated by committees, the written document tends to become unclear and open to various interpretations. Because of these facts and, perhaps, in some cases, other ulterior motives, the enforcement of codes tends to be uneven and arbitrary.

There seems to be a genuine lack of good, well-documented, unbiased performance criteria for housing in both the construction and use-occupancy areas which precludes even the open-minded, enlightened, and willing groups in our courntry, revising and updating the existing codes.

Building Codes (Construction Standards). Definition: A series of standards and specifications designed to establish minimum safeguards in the erection and construction of buildings to protect the human beings who live and work in them from fire and other hazards and to establish regulations to further protect the health of the public.

Housing Codes (Use and Occupancy Standards). Definition: A local or state ordinance setting the minimum standards for safety, health, and welfare of the occupants of housing. They cover three main areas as follows:

1. The supplied facilities in the structure; i.e., toilet, bath, sink, etc., supplied by the owner.

2. The level of maintenance, which includes both structural and sanitary maintenance, leaks in the roof, broken bannisters, cracks in the walls, etc.

3. Occupancy, which concerns the size of dwelling units and of rooms of different types, the number of people who can occupy them, and other issues concerned with the useability and amenity of interior space.

Building Codes as They Affect Housing Production. There is a lack of uniformity, absence of clear standards, and a proliferation of provisions in existing building codes. Even those local codes that are based on model national codes tend to become very particular when amended for local conditions. This situation discourages the development of a broadly-based national housing industry.

No group, public or private, has the authority or resources to develop performance standards for the housing industry. This results in the lack of objective standards by which to evaluate innovations in materials and concepts. This lack of performance standards has also resulted in most building codes specifying materials and methods.

Lack of adequate funds and staffs on a local level coupled with involved and tedious amendment procedures result in out-of-date codes. This condition tends to restrict the use of new products and practices.

Presently, an appeal procedure for the builder from arbitrary decisions and interpretations of the code on the part of the local inspector does not exist. This condition encourages the attitude of "let's do it the way we did it before," thus discouraging innovation.

The understanding of the traditional materials and methods used in the housing industry is widespread, proven, and generally accepted.

The existing building codes reflect the generation and growth of this knowledge. Their enforcement, consolidation, updating, and the opportunity for innovation could be enhanced by the development of performance standards for housing construction.

The current understanding of the less quantifiable aspects of housing, (i.e., minimum and decent) is minimal at best. The housing codes now in use in this country reflect this lack of understanding.

Housing Codes as They Affect the Housing Stock. Currently, not all areas are covered by a housing code. For example, 47 percent of the cities between 5000 and 50 000 within standard metropolitan statistical areas (SMSA) did not have housing codes in 1968. This condition makes it possible to add substandard (according to existing codes) housing to the national inventory in these areas.

Housing code administration or enforcement is presently so inadequate that it does not effectively prevent deterioration of existing housing or improve the quality of new housing under existing standards.

An examination of existing housing codes indicates that much remains to be done to achieve minimum standards for health and safety. For example, the areas covering repair and maintenance, kitchen facilities, ventilation, and rat control are considered by many to be inadequate.

Presently, there is no generally-agreed-upon set of standards for a decent home, much less an understanding of how these standards are related to space, light, air, plumbing, maintenance, and occupancy. This fact precludes the development of housing codes that would raise the housing standards from a bare minimum.

Figure V-1 illustrates the housing code mechanism as proposed by the National Bureau of Standards.

Labor in the Housing Industry. The construction industry includes the housing industry, but there is an important difference in the labor force engaged in housing construction — less than half of it is unionized. The housing industry is extremely cyclic, even more so than the general economy, and it is seasonal, making it less desirable to skilled laborers than more stable industries. This situation also contributes to the feeling of job insecurity on the part of the labor force in the housing industry. Job insecurity, in turn, encourages them to look for the opportunity to get out or, on the local

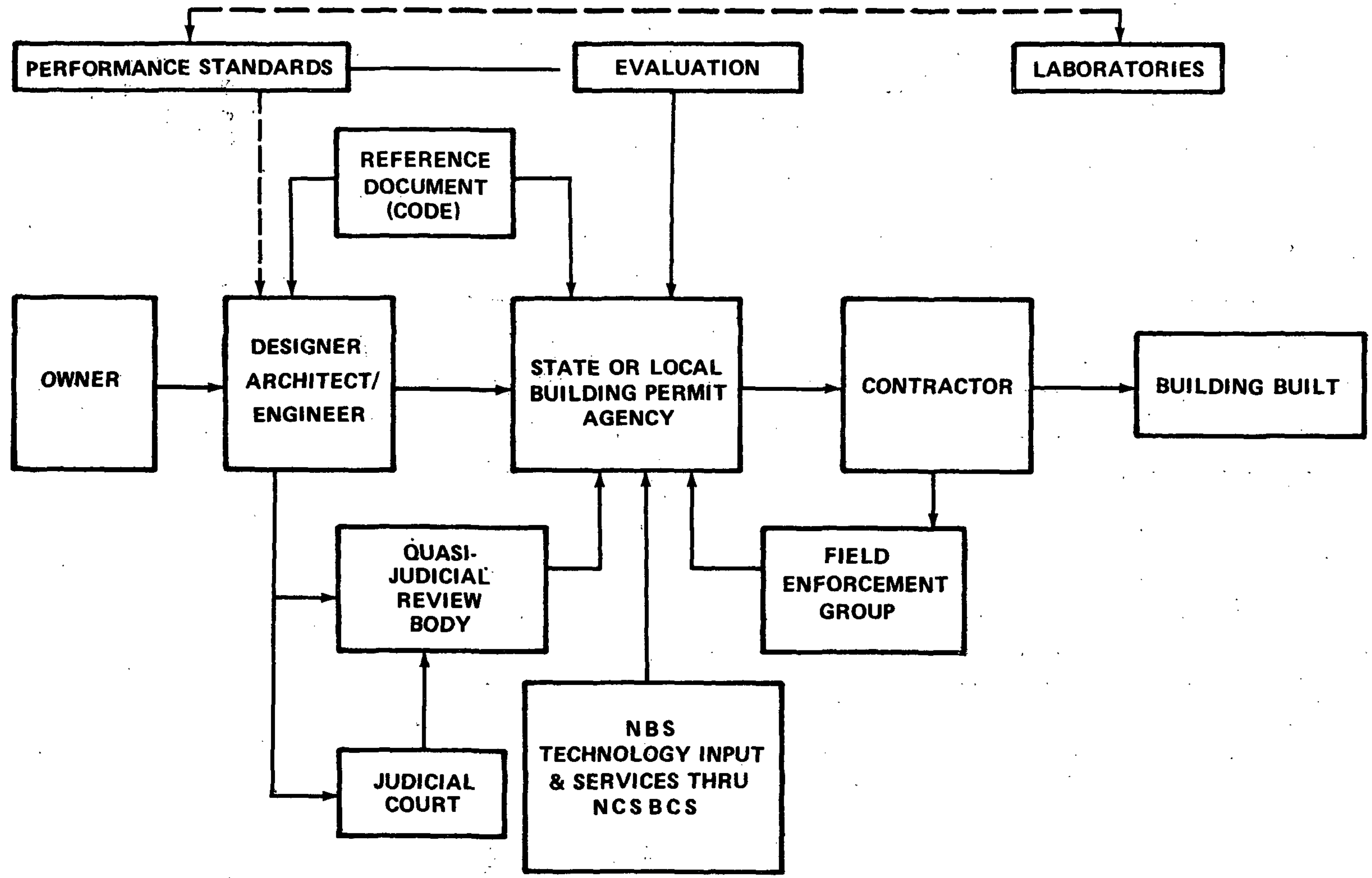


Figure V-1. Housing code mechanism.

level, to demand the institution of restrictive labor practices which appear to increase job security on a short-term basis.

Labor as it Affects Housing Production. There is a recognized shortage (the severity of which is difficult to quantify) of skilled labor in the housing industry. This situation is attributed to the inability of the industry to attract, train, and maintain skilled labor, primarily because of the low annual income resulting from the cyclic and seasonal nature of the industry. A pervasive feeling the the industry of lack of job security encourages the demand for, and institution of, restrictive labor practices, primarily on a local level.

Since there is no reliable way of controlling or predicting the level of economic activity in this country, and since this has a direct bearing on the activity in the housing industry, it is difficult, if not impossible, to determine the future manpower needs in the housing industry.

Adequate training programs for potential skilled workers, particularly from among the minority groups, do not exist. These programs preclude the possibility of maintaining, much less increasing, the supply of skilled labor.

Productivity in the housing industry has not appreciably increased in recent years because of the failure of the industry to fully exploit the following areas:

1. Winter construction.

2. Improving construction management; e.g., scheduling techniques such as CPM and PERT have not been fully utilized.

3. Industrialized housing — it should be noted here that development in this area would relieve some of the demand for skilled labor.

The labor aspect of the housing industry is a "people problem" and as such must be approached with a degree of tact, diplomacy, and even-handedness. Labor must be shown how its own self interests, which are not mutually exclusive of management and public interests, can be served by changes in labor practices which currently restrain increased productivity in the housing industry. Phase changes have already begun to be recognized at the national level within labor.

The housing industry must be stabilized, thus making it more attractive to both skilled and unskilled labor and to some extent, obviating the demand for restrictive labor practices [V-4].

Protective Covenants. Protective covenants, sometimes called private deed restrictions or, more properly, restrictive convenants, are contracts made between private parties which are made to preserve the character and amenities of residential areas and to preserve the value of the property.

Restrictive covenants do not take the place of public regulations, such as zoning. Zoning protection is the governmental control based on maintaining and promoting public health, safety, and welfare. The private nature of restrictive covenants allow them to extend beyond the jurisdiction of zoning regulations in protecting the amenities built into any community development [V-4].

Public Interest Aspect of Land Use. The public interest aspect of land use involves governmental actions to ensure livability by protecting the health, safety, and general welfare of society. The areas of involvement are the following:

1. Health.
2. Safety.
3. Convenience.
4. Economy.
5. Amenity.

The areas of health and safety are normally treated together because of their close relationship. The primary emphasis in these areas has been on the physical health and safety of the community. The primary method to provide for what should and should not be done to protect the public interest in these particular areas is the use of building and housing codes.

A broadening of emphasis in the area of public health and safety is now taking place. It includes interest in protecting the mental and emotional well-being of the people and a desire to plan and build health and safety aspects into the environment.

Planning is evolving from the idea of providing the minimum environment to providing the desirable environment. This planning includes the consideration of the following:

1. Density controls — usually achieved through the use of zoning and subdivision controls, sometimes even housing codes when they address themselves to the doubling up of families in single-family residences.

2. Controls over hazardous area; i.e., flood and marshy areas. This control is normally exercised through public acquisition of the area in question.

3. Control of exposure to adverse environmental influences; i.e., transportation systems and industrial complexes. The effect of these influences can be controlled by technological abatement procedures and minimization of exposure to them through land-use planning procedures.

Convenience, which includes the time and effort required of people to go to work, shop, recreate, etc., depends primarily on two factors: (1) The transportation factor which provides the means of access to the various public services, and (2) the intensity of development which, for convenience, would provide for high-order densities. There is a tradeoff to be made between this tendency for high-order densities and the low-order density required for health and safety. Normally, zoning and subdivision regulations attempt to provide for public convenience.

Economy, in the sense it is used here, can be considered the cost of time and effort to the citizens of a community. It depends on the location of use areas and the intensity of development. Economy is very closely related to convenience; in fact, it might be considered as the cost of convenience. It is achieved by zoning, subdivision regulations, and establishment of major street locations.

Amenity depends on the perceptual aspects of the environment. As a result, it involves the public taste which, in turn, results from a wide variety of individual values. Public tastes are sometimes difficult, if not impossible, to ascertain except at extreme conditions. This difficulty should not be used as an excuse for excluding this factor from the land-use planning process.

Another very important point about planning the use of land considering amenity is that the concept of amenity should be the community's concept of amenity and not that of the planner.

Where amenity is currently being provided for, it is accomplished by land-use plans reinforced by zoning, subdivision control, official maps and developmental measures [V-5].

<u>An Opinion of National Land-Use Planning.</u> In formulating alternative land-use plans, or alternatives to land-use planning, interrelated phenomena should be considered. The primary objective of an emerging nation is to develop its natural resources to sustain its people. Forests are cut, fields are plowed, and minerals are mined (this has been accomplished). Yet, the primary objective of an emerging civilization is to develop its people to sustain its resources (this has not been accomplished).

Civilizations may be defined as patterns by which man gives order to his environments. These ordered patterns are identified by philosophies (understandings of agreed truths) and by technologies (capacities to utilize resources). Interdependent and transitory philosophies and technologies are shaped by, and give shape to, the environments. The degrees of well-being experienced by a civilization are proportional to its success in shaping environments that express its agreed underlying truths and principles. Conversely, comparative lacks of well-being within nations may be traced to either an inability to physically express agreed truths and principles or to a lack of concensus and agreement of underlying philosophies. For example, controversy over reorienting national priorities may be symptomatic of philosophic conflict between one generation trained to develop resources to sustain people and another generation trained to sustain resources to develop people, a conflict between nationalization and civilization as an underlying truth.

Nations traditionally encourage resource development, then initiate laws to broaden economic distribution within acceptable limits of natural and social exploitation. Nations lacking balanced resources attempt to extend economic and political boundaries. These are, essentially, political and economic processes designed to balance social and natural resources. Perhaps a more effective approach might be to design social and natural systems to balance economic and political processes.

To place people and resources before law and economics may appear revolutionary as it was in the 1770's. Yet, such concepts, of which national land use planning is central, need not appear drastic if existent pressures are understood and accepted as normal in the transition from

resource to social development. Consider the alternatives: (1) to continue constructing the status quo, (2) to prepare for a depression, or (3) to design for a future of unlimited affluence.

1. What status-quo should we continue to construct? It is possible through industrial overkill of the ecology to destroy our natural resources. Part of our society wishes to legislate a return to the good old days (a wish that was made increasingly difficult by population and communication pressures). Others feel that we must change or the demands of increased millions will lower the quality of life below acceptable standards. They claim that environmental discontent forces the frustrated to become revolutionaries. Others recognize civil rights as environmental rights (housing; education; clean, safe, and enjoyable cities; work and recreational opportunities describe environmental conditions, not politics). Others are still frustrated by altruistic, but, increasingly, ineffectual attempts to keep the establishment running. These are but some of the threads in our current blanket of malaise. The present is untenable.

2. What immediate changes could we expect from a depressed future? For example, if our ability to utilize energy decrease (or increase at a slower rate than our population) through the ravages of war, inefficiencies of production, or reduced strategic imports, there would be an exodus from metropolitan areas incapable of supplying food for its people or power for elevated office buildings. Small towns supporting garden plots and handicraft industries could rematerialize. Mass transit systems, in replacing automobiles, would encourage increased densities. Within cities, fine-grain zoning would increase to encourage walking to the school, the job, or the grocery store. There would be increased need to build without steel, aluminum, glass, or chrome. Labor would be cheap and materials expensive. Political philosophies would become more conservative and individualism would decrease. Educational institutions would be trimmed of tenured fat, since only great scholars and those teaching practical ways to rebuild the environment could be supported by a power-starved country. Occupational specialization would decrease.

It is logical to assume that national land-use planning designating the best use of continental resources would be implemented. These plans might locate communities to best produce and distribute food, fibres, and facilities without overkilling their host ecology or overloading the transit systems. Building codes rejecting excessive power usages, wasteful setbacks and sideyards, or the use of scarce materials would be implemented.

Architectural concepts working with, rather than against, natural phenomena would develop. The availability of inexpensive labor would encourage a return to craftsmanship.

We could envision a nation of small, well-spaced, ecologically defensible and humanly enjoyable towns. It is even conceivable that we would mine our abandoned suburbs and cities for recoverable minerals (use abandoned materials; e.g., copper pipe, glass, steel, etc.).

3. What immediate changes could we expect from a future of affluence? If we are capable of increasing the quantity and distribution of per capita energy (through scientific, management, or industrial breakthroughs), equally vast changes would take place as follows:

a. The rush of metropolitan suburbs would accelerate.

b. Many more small towns would die.

c. Less manpower would be needed to run industries and cultivate the land.

d. Production would be divorced from consumption; i.e., factories not needing people would not be located in cities.

e. Many would leave chaotic cities to live in new towns designed to lead the "good life."

f. Philosophies would become more liberal; human values of identity, meaning, and purpose would be increasingly reflected in national policies.

g. Occupational specialization would increase to satisfy the development of humans as individuals, and to meet the demands of an informed and discretionary society.

h. Higher education would flourish; many would go to school for life.

i. Mobility would increase, yet massive communication systems would eliminate unnecessary travel.

j. Genetic family ties would become less important as each would go his own way to enjoy and serve the community of man.

k. Optimal use of resources would require recycling of strategic materials.

It is logical to assume that national land-use planning designating the best use of continental resources would be implemented. These plans might locate communities to best produce and distribute food, fibres, and facilities without overkilling their host ecologies or overloading their transit systems.

Modular and possibly megastructure construction would be logical. Micropower systems would be utilized. Satellite surveys of resources and sophisticated management systems would develop. Architectural and planning concepts reflecting symbiotic balances between natural phenomena and scientific technologies would develop.

We could envision a nation of moderately sized, technically sophisticated, ecologically defensible, and humanly enjoyable cities.

Reality will lie somewhere within the limits of these three futures. However, in spite of vast apparent difference, common principles exist to shape policies. A depressed society and an affluent society differ primarily by the amount of distributed per-capita energy. All other differences are essentially symptomatic. The character and quality of a culture is dependent upon the types and amounts of energies distributed per capita. Technologies change the environment by increasing available per-capita energy. Environmental changes generate equivalent changes in acceptable human actions.

For each condition, there is a logical series of solutions as to how many people, possessing what machines and moralities, can live where, in what densities, doing what. Logical sites to accommodate an expanded and decentralized population in small towns or sophisticated cities will be needed. Their size and spacing will be dependent upon per-capita energy levels. Their locations will capitalize upon existing navigable waterways and the rights of ways of railroads and interstate highways.

Intelligence plans are essential to survey and logically distribute human and natural resources to meet either of the extremes mentioned, and significant increments between these extremes. If this information is available to defend our country, it should be made available to build a nation that justifies our defense efforts. Land-use planning is central to this issue.

Efficient mass transit systems are essential to whatever future we may experience. Automobiles cannot survive a depression nor can cities support the automobile in periods of affluence. Airplanes cannot economically

transport industrial raw materials, the majority of its finished products, a depressed population, nor the unlimited travel demands of an affluent society. Efficient mass transit is an absolute necessity. Land-use planning is central to this issue.

If we experience a depression, densities in urban cores and small towns will increase (Fig. V-2). If we experience affluence high density, new towns designed for people to live the "good life" will be created. If the status quo is maintained, increased densities to increase the tax base while reducing service costs will be encouraged.

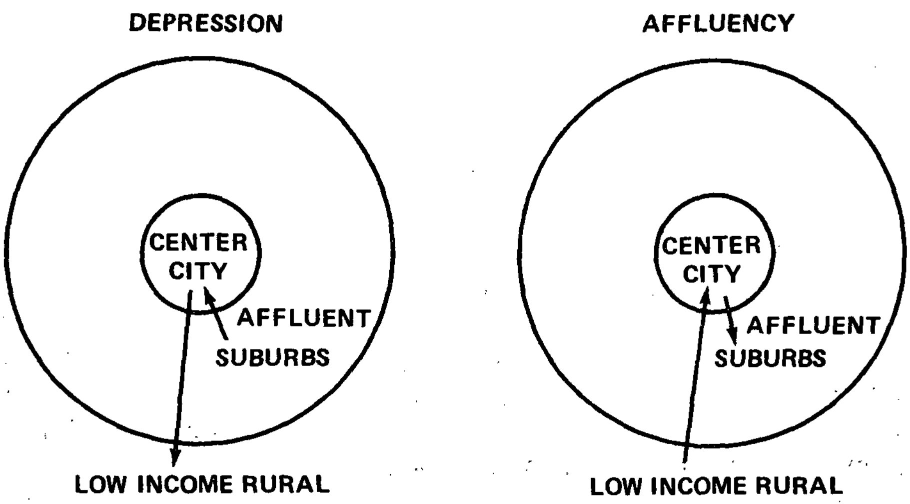


Figure V-2. Circulation of population.

It must be recognized that our cities and homes are the only essential artifacts to our society that are not designed. Central to the concept of designed environments is the concept of national land-use planning of optimally spaced high-density communities whose perimeters are restricted to increase efficient civic services and to permit the urban dweller ready access to the delights of the rural countryside.

It is conceivable that city-states may be formed as the one-man-one-vote political concept concentrates political power in urban areas. Again, land-use planning that is balancing rural and urban interests is essential.

<u>Land-Use Planning Legislation.</u> Should land-use planning be recognized as essential and how should it be operated and administered? The

Environmental Protection Act of 1969 currently in its infancy is currently establishing standards that influence land use. Extension of these powers to encourage good use rather than restrict misuse may be one approach. To be effective, dualities and overlapping jurisdictions with the Department of Transportation and the Housing and Urban Renewal agencies should be eliminated. It appears essential that mission-oriented agencies establish flexible intelligent land-use plans (incorporating housing, urban development, and transportation).

Currently, in the 92nd Congress, there is considerable discussion and action relating to the land-use planning concept. The Senate Committee on Interior and Insular Affairs (Henry M. Jackson, Chairman) has two land-use planning bills before it: S. 632, sponsored by Senator Jackson, and S. 992, sponsored by the administration. Both bills relate to housing through the indirect path of land-use and would provide an important parameter in the housing mechanism. "To a very great extent, all environmental management decisions are ultimately related to land-use decisions. All environmental problems are outgrowths of land-use patterns. The collective land-use decisions which we make today and in the future will dictate our success in providing the American people with quality life in quality surroundings."

"Adoption of a balanced national land-use policy would make it possible to identify tradeoffs, to compare, on a national basis, alternative proposals, and competing social purposes through the demands they would make upon our most universal and basic resource."

"Experience during the past year has strengthened the realization that adoption of a national land-use policy is a matter which cannot be delayed. Data from the 1970 census show the trend toward high-density habitation continuing. The latest figures reveal that over 70 percent of the population presently occupies less than 2 percent of the land. The consequent pressures on urban centers, recreation areas, transportation systems, and power supply facilities continue to increase."

"In addition, our ability to accommodate the energy requirements of a growing population and expanding national economy is a matter of critical concern. Energy demand continues to rise at a rate of 5 percent a year and demand for electricity is expected to increase 284 percent by 1990. There is a real question as to whether or not we will have the resources and management ability to meet this demand. If present trends and policies are allowed to continue, it is clear that we will not."

"These and many other examples all point to the need for a comprehensive land-use, planning, management, and development policy. Without such a policy, it will be impossible to meet the needs and aspirations of a growing population while conserving for ourselves and for future generations a quality environment."

"When one considers the significance of land-use planning and management to the achievement of a wide variety of our national goals, it becomes apparent that our past efforts to make rational land-use decisions in the overall public interest have been inadequate. Today, most land-use decisions remain almost totally private decisions, even though they often result in public costs far beyond the proprietary interest of the decisionmaker."

"At the other extreme, public decisions on major facilities such as highways, water resource projects, and airports predetermine the development of land-use patterns on a regional scale for decades to come and are often made with scant appreciation of their impact on state and local interests, on the environment, or on the long-range public [V-6]".

A national land-use policy and plan is therefore essential for understanding and rationally using this limited resource — land.

In an informal discussion with a staff member of the U.S. Senate Committee on Interior and Insular Affairs, the impressions of the comparisons between the two pending congressional bills on land-use planning were formed and are listed in Table V-1.

The task group subscribes to a recommendation in a report entitled "Better Housing for the Future" made to the Panel on Civilian Technology in April, 1963, that the Federal Government undertake to obtain statistics which would advance housing technology but which cannot be obtained completely by the housing industry itself... A properly organized information-gathering program would provide the government with an excellent opportunity to make forecasts, set policy, and determine in detail the utility and efficiency of the FHA minimum standards, as well as assist the industry as a whole.

Since space-age technolgoy includes an expertise in information collection, analysis, and dissemination, it is felt that a possible feasibility of transferring this expertise to the housing industry exists.

TABLE V-1. COMPARISON BETWEEN TWO PENDING CONGRESSIONAL BILLS ON LAND-USE PLANNING

S. 632 (Senator Jackson)	S. 992 (Administration)
• Emphasizes planning	• Emphasizes implementation
• Penalties and incentives strong	• Penalties and incentives weak
• Balanced with respect to environment and economy	• Very environmentally oriented
• Demands data and information for decisions (recommends data bank)	• Not data oriented
Both bills tend to give state power over local and federal over state; purpose is to reduce number of narrow based judgments concerning use of land	
• Jurisdiction under the Water Resources Council	• Jurisdiction under the Interior Department with assistance from HUD
• Demands comprehensive state planning • Includes social areas very slightly	• Demands planning regarding (1) environment, (2) key facilities such as dams and airports, and (3) areas of regional development neglect social issues

Public Services. Public services available to the land developer and and locational opportunity of the land and those associated with developing it have a great influence on the various aspects of the land-use process.

Only a list of possible considerations is presented below and the reader is urged to use the references for a more thorough study of their relationships:

1. Accessibility.

2. Topography.

3. Geology.

4. Service Utilities.

   a. Electricity.
   b. Water.
   c. Sewer.
   d. Sanitary storm.
   e. Gas.
   f. Telephone.
   g. Television.

5. Highways and/or other transportation to:

   a. Central business district.
   b. Work.
   c. Schools.
   d. Churches.
   e. Hospitals.
   f. Recreation areas.
   g. Shopping centers.

6. Fire protection.

7. Police protection.

8. Open space.

9. Waste disposal.

10. Street service (snow removal, sanding, cleaning, and lighting).

11. Flood control.

12. View.

13. Pleasant surroundings (lake, mountains, seashore, trees, man-made beauty, and personal preference).

14. Odor control (air pollution control).

15. Noise control.

16. Airport and flight path annoyance.

17. Industrial activity.

18. Density of population.

19. Communication and participation in local government.

20. Zoning.

21. Area master plan.

Economic Considerations

Taxation. Private housing decisions are affected by aggregate fiscal policies. However, it is important to note that the overall tax level may be high without necessarily having a differential effect on housing decisions.

What is needed is the relation of taxation to an arbitrary reference point; i.e., detection of an imbalance in the effect of taxation with respect to housing consumption and housing investment.

Tax systems are complex and have not been pursued with a conscious effort toward preserving a neutral effect on the housing mechanism. A problem for investigation could be directed toward quantifying the effect and developing a functional relationship to be included in the housing mechanism model described later.

There are two basic types of taxes; income tax and indirect taxes.

There are at least three aspects of income taxation that may produce unbalanced effects on housing. Treatment of capital gains, provisions for depreciation fund investment allowances, and treatment of income and expenses connected with owner-occupied housing exist. Let us see the relationship to housing, for example, with capital gains.

Property developers often do not retain ownership for very long periods, but rather sell their interests to long-term investors. If capital gains are treated favorably in tax laws and if property developers can secure this favorable treatment, this kind of investment will be encouraged.

To get an idea of how the capital gains portion of income tax affects the housing mechanism, look at two items: (1) does a country's personal and company income-tax system treat capital gains favorably? and (2) does the favorable treatment apply in an equitable way to real estate and other investments? It is equal in the U. S.

However, recent changes in the investment credit and depreciation have caused a shift from positive encouragement of multifamily housing investment toward a negative effect.

Indirect taxes are applied to particular segments of the market rather than being generally applied. Also, they are often designed to cause an imbalance in a market system; i.e., they are not neutral (e.g., the tax on gasoline and tobacco products). These taxes are not designed specifically to alter the housing production or consumption, but there is an accidental effect.

The three major indirect taxes that produce an imbalance are (1) tax on value of real property, (2) property transfer tax, and (3) turnover tax (state sales tax).

Taxes on the value of land and buildings are usually for fiscal support of local governments. The real property tax in the U. S. in 1962 was 12.6 percent of the total tax revenue (local, state, and federal tax). In the U. S., the real property taxes on housing comprise a large percentage (3.5 percent) of the national income. In 1963, housing property taxes, about $ 9.2 billion, equalled 20 percent of the rental value of nonfarm dwellings. Turnover taxes (state sales tax) are applied to housing in areas of the U.S. in which 85 percent of the population lives. This tax is seen in the cost of construction materials, purchased maintenance, materials, and services.

Since real property conveyances involve official recordings or registrations, they have been popular objects of taxation. However, while real property taxes are high, the real property transfer taxes are low and nondiscriminatory in the U. S.

Thus, in some respects, two forms of indirect taxes affecting housing (real property and property transfer) may be considered to partially offset one another. Here though, one must carefully investigate the relative magnitudes of the effect on housing, particularly when preparing the functional relation in the housing mechanism model described in Chapter VIII. It is noted that on an international scale, the capitalized costs of a high annual property tax of the American variety is likely to far exceed even the highest transfer tax known in any other country.

In some countries other than the U.S., in which real property taxes are of importance, land values are often taxed at rates which are higher than those applied to buildings. In such cases, the so-called land value taxes do not necessarily provide a counter-incentive to housing consumption or investment. The buyer of housing sites offsets the higher annual taxes with a lower purchase price. In fact, the high land value taxes actually tend to encourage housing construction, which is affected by increasing the annual costs of holding land suitable for housing causes a more smoothly functioning market in development sites.

In relation of taxes on expenditure, the U. S. tax system is against housing in general. While the general retail sales tax rate is 5 percent, the housing property taxes are about four times this level. Even excluding taxes on consumption of gasoline, alcoholic beverages, and tobacco, indirect taxes on nonhousing consumption in the U. S. total 10 percent. Housing property taxes are nearly twice this level.

There is some measure of imbalance in favor of housing consumption for the owner-occupier of a house through the federal income tax advantage of deducting mortgage interest and local property tax payments in computing taxable income. It appears that the tax system as a whole is against rental housing.

Also, changes in federal income tax provisions with respect to depreciation allowances, investment credit, and capital gains affect substantially the amount of investment in and consumption of rented housing. This fluctuation was negative (decreased investment in housing) in 1963

In the U. S. tax system, from the standpoint of consumer decisions as to the way in which personal income is spent, housing is treated relatively unfavorable; i.e., the tax system is against housing consumption [V-7].

An example of the confusing relation of taxation to housing is a consideration of city income related to owner occupancy. Consider the case of San Francisco which has one of the highest percentages of rental housing of any major American city. In 1960, this figure stood at 65 percent. However, the tax base of the city is heavily dependent as it is in most cities on a property tax. In fact, San Francisco has one of the highest ratios of property taxes in the country. As in many places, the taxes rise faster on improvements to the land than on the land itself. From these influences a number of problems arise:

1. Rental housing is normally maintained less well by the occupant than is owner-occupied housing. However, the owner-renter cannot afford to maintain or upgrade the property over the long run because of the substantial increase in his taxes.

2. The city is unable to enforce codes or other policies because of the small tax base.

3. The city has trouble in other areas because of the tax base situation.

4. Since the populace is preponderantly renters and see the tax in only a secondary sense (higher rents), it is difficult to vote in a new tax base measure.

There are cases in other cities that would reveal that the heavy reliance on the property tax to provide services for the city is an inefficient means of meeting a perceived goal. One case in point is the recent rash of public school bond issues being defeated at the polls since the users of property taxed items felt the direct increase in living costs are imminent.

Through an intensified search for understanding of interactions through the means of the housing mechanism model, a more equitable and satisfactory means of supporting public interests may be found.

Discussion of Government Housing Program. Most discussions of housing deal with aspects of federal housing programs; i.e., what are the

programs? What can you get from the government? What are the latest legal revisions? These factors may be important and are certainly well documented.

Much confusion and mystery still seems to cover up the real issues regarding the programs. First, many problems have stated by those working to implement these programs. Secondly, carrying the weight of law, federal housing programs state certain national policies. Through interpretation and administration, they have failed to fully achieve their implied intent. Thirdly, if this failure is the case, then what might be suggested to bring the statements of broad policy into effective implementation in the housing market place?

Many speakers at Auburn Design Program stated that the federal housing programs are central to both the cause and solution of the nation's housing problem. Some have indicated that it is red tape that is the cause of great misery. Admittedly, this has provided the government with a filtering device that has channeled, limited, and, to some extent, balanced federal expenditures. Others have stated that a lack of knowledge of what is available or of how to use the system is the real problem. These examples seem rather picky and probably not real problems but symptoms of bigger ones.

Further, it has been stated that federal programs are limited in scope and inflexible to the needs to the people they were intended to serve. This may be a real problem.

Beside these negative comments, a general recurring reference seems to have been made to the necessity of governmental support for housing by almost all of the speakers. Only Julius Stulman is in favor of a laizze-faire attitude. Even the representatives of private industry have admitted that without certain federally-insured and assisted programs to buffer their market through troubled times they probably would not have been able to have maintained the volume of production necessary to stay in business.

For government and industry to work cooperatively together, striving to meet the nation's housing needs, seems to define one major aspect of national policy in this regard. The 1949 Housing Act contains the following statements of policy: "Private enterprise shall be encouraged to serve as large a part of the total market as it can," and "government assistance shall be utilized where feasible to enable private enterprise to serve more of the total need."

How is government assistance provided to the Nation's people? Is it given only to the poor and needy? It seems that forms of government assistance to the various income levels strikes a fairly even balance across

the spectrum; i.e., on a per capita basis about as much is accounted for in relief dollars to the poor and nonpoor with any imbalance in favor of the wealthy. For the poor, this relief in housing dollars takes the form of public housing and public assistance. For the nonpoor, the break is in income tax deductions on mortgage interest and ad valorem taxes. But what is done for nonpoor renters?

Undoubtedly, this description of government assistance is oversimplified. The millions of dollars expended by the government in urban renewal efforts, model cities programs, Operation Breakthrough, etc., are not accounted for. There are more than 150 separately funded programs in the Department of Housing and Urban Development of which approximately 30 relate directly to housing. Some 10 other agencies of government administer housing programs. The most successful housing programs were designed to help middle-class individuals obtain mortgage financing. They were successful because they were constructed to fit the existing market forces. They involve an elaborate administrative network but actually cost the government very little. Only safe risks were insured. This is now a changing policy.

Now what might be changed? Do we want programs that better reflect the intent of broadly stated national policies or would we do better in terms of evaluating our efforts to restate the goals and objectives? How do you get the housing system to work? How do you measure its workability? Presently, we have only an unsatisfactory end product to hold out as the indicator of failure.

A larger degree of flexibility is built into the programs as they now stand than is generally being utilized. Changes in interpretation of the laws offer some possibilities. One example for potential enlargement of the programs lies in the creation of state housing agencies such as exists in New York. These organizations can have broad legal powers to effectively deal with many of the troublesome aspects plaguing the industry. They can override local codes, work across local barriers, etc. As David Pellish of the New York State Agency has shown, this approach is no quick answer to all ills. It does provide fertile ground for innovation to be tried.

The coordinating body of the newly restructured Department of Housing and Urban Development at the state level also works at the state level. This move might be taken as an incentive to further the efforts at this level.

A totally different suggestion might be to work on the housing problem at the local market level. A model or analysis system should be developed to

more effectively understand how this industry operates at its market place level. However, much data would be needed that presently is highly regarded as proprietory. Just the definition of the local market elements is no small task. It is made up primarily of builders, suppliers, and buyers but affected by factors and other markets beyond their sphere of control. Many questions arise from this very problematic heart of the building industry. How large is a local market or, in an idealized sense, how large can it be and be optimal? Maybe it is too small?

In the context of federal housing programs, a local market model might resolve the questions of policy implementation. It might be able to establish a balance of programs across local levels. In fact, there might be little need for subsidized housing and individualized government protection. On the other hand, the model might show that all housing should be subject to full control.

In relation to the model developed in Chapter VIII, Figure V-3 illustrates the government policy process block.

Discussion of the Elements and Intra-actions of the Capital Function. Comments on the basic laws relating to the Federal Reserve System, the federal reserve banks, and member banks are as follows:

Section 335 says that state member banks are subject to the same limitations and conditions in dealing in investment securities as are applicable to national banks.

Section 355 states that federal reserve banks have power to buy and sell bonds and notes of the United States in the open market (Federal Open Market Committee directs and regulates). A federal reserve bank has power to hold maturities not exceeding 6 months from date of purchase issued against anticipated revenues from any taxing authority.

Section 24 — Any national bank association may make real estate loans secured by first liens upon improved real estate, including improved farmland and improved business and residential properties. Securities may, included mortgage trust deed or other first lien instrument upon real estate in fee simple or on a lease, hold under lease for 10 years beyond maturity of loan.

Amended by the Housing and Urban Development Act of 1968, Section 1718 (1), construction loans may be issued for a period not exceeding 36 months. There must be a valid and binding agreement by a financially responsible lender to advance the full amount of the bank's loan upon completion

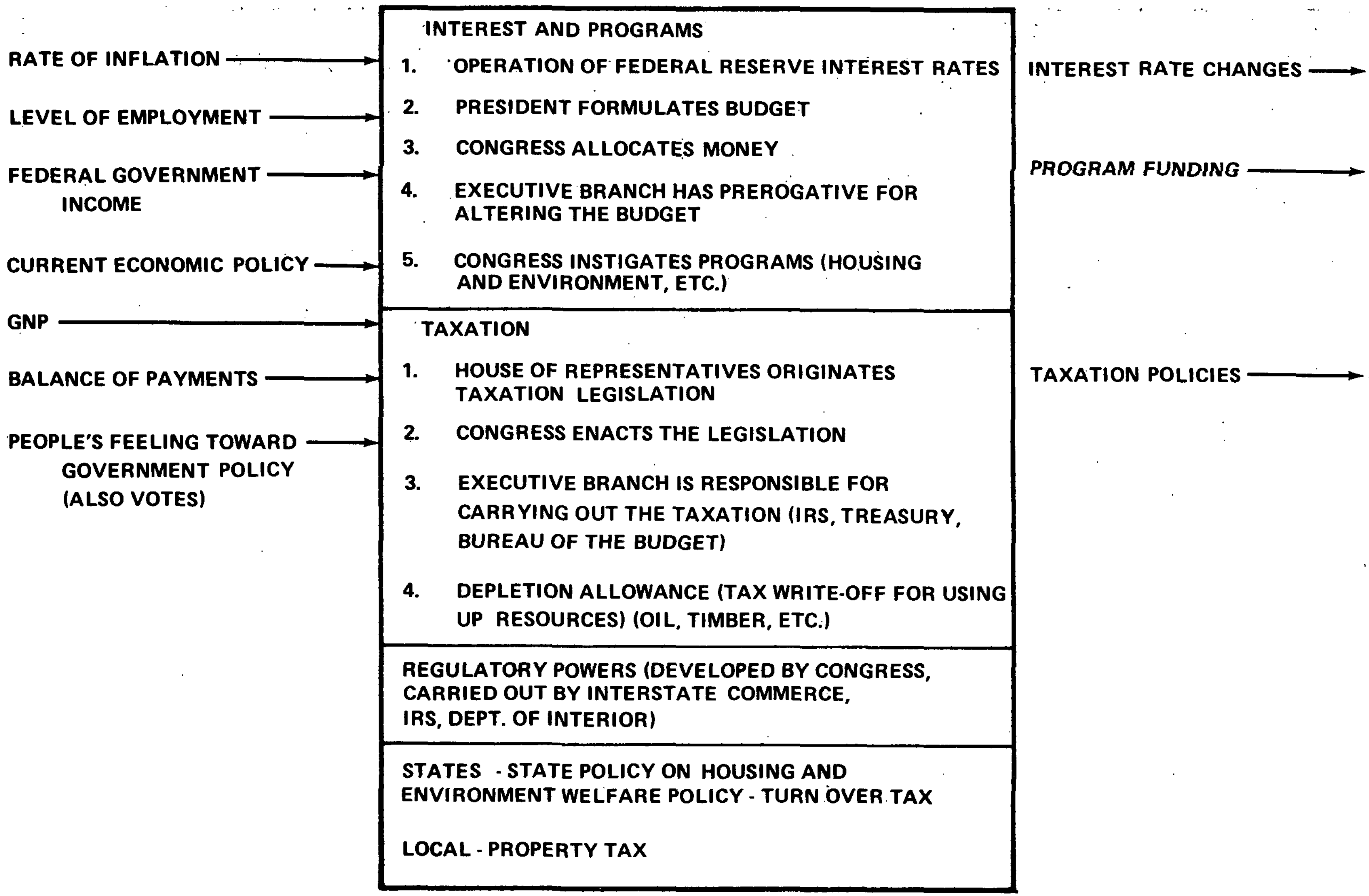


Figure V-3. Government policy process.

of the buildings. Loans in which the Small Business Administration cooperates through agreements to participate under the Small Business Act shall not be subject to conditions or limitations of Section 24 of the Federal Reserve Act. Insured home improvement loans of this title may be made without regard to first lien requirements.

Regulations of Private Financial Institutions — The operations of financial institutions are restricted and limited by numerous laws and regulations. Within this regulatory framework the money game is played. Listed below are only a few of the more outstanding limitations in law on various kinds of financial institutions:

1. Federal banking laws.

a. Federal Reserve Act (Section 24).

(1) Restricts down payments (20 percent) and maturities (25 years) of mortgages made by national banks.

(2) Limits the terms on construction loans made by national banks (36 months).

b. Federal Reserve Act (various sections).

c. Establishes eligibility requirements for paper discounted by the federal reserve (penalties and points).

2. Federal Savings and Loan Associations.

a. Home Owners' Loan Act (Section 5c, \$ 40 000, 100-mile radius) and Federal Home Loan Bank Board regulations (\$ 31 500, 90 percent at 1/5) 80 percent.

(1) Limits size of mortgages.

(2) Limits minimum down payment.

b. Federal Home Loan Bank Act (Section 5).

c. Imposes national usery law on members.

d. Limits interest rate member charges.

e. Maximum permitted by state limit or 8 percent if none is stated.

3. State laws.

a. Mutual Savings Banks (chartered only under state law).

b. Restricts composition of bank's portfolio.

c. Limits loan-value ratio and maturity on mortgages (generally less than federal restrictions).

d. Limits size of allowable mortgage (low).

e. State chartered banks (80 percent, 25 years).

f. Limits loan-value ratio and maturity on mortgages.

g. Limit geographical area.

h. Restricts composition of bank's portfolio.

i. State life insurance companies.

j. Limits loan-value ratio (75 percent).

4. Pension and mutual funds (1968, \$ 200 billion, \$ 10 billion in mortages).

a. State and federal government pension funds controlled by government administrators.

b. Investment Company Act of 1940 controls registration of mutual funds.

5. Federal Home Loan Bank System — Chartered by Home Loan Bank Act (1930's).

6. Federal Home Loan Bank Board.

a. Supervisory powers over member savings and loan associations: Liquidity requirements (6 percent), member association must hold fixed portion of assets in liquid paper cash, FHLBB deposits, government securities, etc.

b. Federal Home Loan Bank Act, amended 1968 (Section 5a).

(1) Board empowered to vary imposed liquidity requirement from 4 to 10 percent.

(2) Classifies associations (by rate of deposit withdrawals).

c. Lines of credit.

d. Federal Home Loan Bank Act (Section 11e) — Authorizes each bank in system to accept deposits made by members of such banks.

7. FHLBA (Section 5b) — Aggregate liquidity requirement may include deposits held in the home loan banks.

8. FHLBA (Section 10a) — Each home loan bank is authorized to make advances to its members upon securities of various collateral including home mortgages.

9. Emergency funding from U. S. Treasury.

a. FHLBA (Section 11i).

b. Authorizes system to borrow up to $1 billion from U. S. Treasury.

More detail on the various parameters and functional relationship of capital as related to housing is given in the next section, where the intra-actions and interactions of the housing mechanism are presented.

1. Introduction of capital function.

a. Purpose of capital function.

(1) Medium for transfer.

(2) Conceptual model.

b. Description of work below.

(1) Inputs.

(2) Outputs.

(3) Elements in function.

(4) Interactions.

(5) Relations with other functions.

c. Why model the capital function for the entire economy?

(1) Many uses of capital.

(2) Lack of specialized suppliers.

(3) The need for more than mortgage capital in the housing model.

2. Inputs to Capital Process.

a. Supply of capital.

(1) Sources.

(a) Households.

(b) Businesses.

(c) Federal government.

(d) State and local government.

(e) Commercial bank — demand deposit creation.

(f) Federal reserve — primary deposit creation.

(2) Relative importance of sources in post.

(3) Determining value of each of these sources and using it.

b. Information about effective demand.

(1) What is demand?

(2) Types of demand.

(a) Households.

1 Consumer finance.

2 Mortgages.

(b) Businesses.

1 Capital financing.

2 Operating financing.

(c) Federal Government budgetary deficit.

(d) State and local government capital finance.

(3) *Demands which are particularly important for housing* system.

(a) Households

1 Mortgages.

2 Consumer finance for home improvement.

(b) Business.

1 Capital improvement for producers of building materials and products.

2 Operating capital for suppliers, contractors, and developers.

3 Corporate developers — Long-term finance, bonds, stocks, and mortgages.

(c) Federal Government —Federal insured mortgage bonds.

(d) Local and state governments — Capital improvement bonds, highways, housing authorities, etc.

(e) Effective demand for mortgage capital.

1 Effective demand.

2 Assisted effective demand.

a. FHA.
b. VA.
c. Subsidy program.
d. Tax deductions.

c. How the intermediaries know about demand.

(1) Feedback.

(2) Feedforward.

d. How effective demand can be estimated for the model.

3. Outputs from the capital process.

a. See items 2.b. (2) and 2.b.(3) and reference item 2.b. (2) as applies to demand.

b. Relative past importance.

4. Elements in the capital function.

a. Definition of classes of elements.

(1) Line organizations.

(a) Savings and loans.

(b) Commercial banks.

(c) Mutual savings banks.

(d) Life insurance companies.

(e) Pension funds.

(2) Control elements.

(a) GNMA.

(b) FNMA.

(c) Federal Reserve.

(d) FHLBB.

(3) Service elements.

(a) Mortgage companies.

(b) Securities markets.

5. Interactions.

a. Reference to element descriptions.

b. Sample routing of funds.

c. Modelling interactions.

(1) Approach used in decent home.

(2) Modelling decisionmaking processes.

6. Manipulating the capital function.

a. Using model.

b. Types of innovation in function.

(1) Changes in vote of supply of money savings.

(2) Changes in how capital is allocated.

(3) Change in demand.

7. Summary

a. Reiterate reason for modelling all capital.

b. Objectives.

(1) Control
(2) Priorities } Both are required.

The development toward an intra-active model is presented in the semi-outline form below.

The effort represented in this section should not be understood as a model. It is an early iteration in a process involving successively more complex descriptions of the money function. The purpose of this process is to understand the function by indentifying its inputs (both resources and management), and its output (the criteria implied). It should be understood that no explicit criteria have yet been formulated for the housing system nor for this function.

Money

1. Functions of money:

a. Medium of exchange.

b. Measure of value.

c. Store of value.

2. Definition of money — Anything generally acceptable in exchange for goods and services (ultimately resources).

a. Currency and coin.

b. Bank accounts.

3. Functions of money give rise to a separate market in money; i.e., money becomes a commodity.

a. It is the rationing device.

b. Producers are specialized.

c. Savers and investors are different.

4. Financial markets serve the function of distributing money to those who need it. The underlying motive for distribution of money is a capital formation process; i.e., the need to use resources to produce goods and services.

5. Supply of money.

a. Concepts of supply.

(1) The law of supply.

(2) Elastic and inelastic supply.

(3) Short- and long-run expansion.

b. Supply of money.

(1) Fix supply of savings in system.

(2) In the short run expansion only, changes possible are in form of savings.

c. Types of supply.

(1) Personal savings.

(2) Corporate savings.

(3) Federal government.

(4) Local and state governments.

(5) Commercial banks.

(6) Federal reserve banks.

d. Distribution of supply to intermediaries.

e. Representing supply in the model — Effects of differing economic situations.

Does the law of supply hold for money? The law of supply simply states that the quantity offered by sellers increases with the price. The supply is inelastic when a large change in price produces a relatively small change in the supply. It is elastic when a small change in price results in a large change in supply.

6. Supply of funds — Money is made available for investment only if income is saved or new money is created. The supply of investment money involves two decisions:

a. To forgo spending income for consumption.

b. To give holding the funds in liquid assets.

7. Sources of funds — Tables 11 and 20-1 of Reference V-8 show personal saving relative to disposable income and consumption expenditures, and the following observations may be made:

a. The rate of savings relative disposable income or GNP is relatively constant.

b. Wartime and depression savings rates are notable exceptions.

c. Rate of savings appears to be relatively inelastic with respect to interest rates. People apparently do not save to earn interest [V-8].

8. Corporate savings — A significant portion of savings is made by corporations retaining earnings and accumulating depreciation. Management of money corporations have reinvested retained earnings to promote corporate growth and retain control. Savings through retained earnings seem to be elastic with respect to corporate profit and inelastic with respect to interest rates.

Accumulated depreciation is a significant source of saving. The primary purpose of depreciation is to recover investment in used capital equipment; however, it respects added value in two ways:

a. Recovered funds can be reinvested in different production assets.

b. To the extent that the government allows depreciation of capital asset more rapidly than they are expended, and real addition value is created.

Many large corporations now rely entirely on these internal means of generating investment capital.

9. Federal government — The federal government generates savings through budget supplies and by taxing finance for essential capital assets. The latter is relatively unimportant in this century. Savings generated through budget surpluses are inelastic with respect to interest rates as the government generates surplus for economic reasons.

10. State and local governments.

11. Commercial banks — Demand deposit creation.

12. Federal reserve banks — Primary reserve creation.

a. Effect of changing interest rates.

b. Change in interest rate does not significantly effect the saving rate, but they effect the form of savings; i.e., the distribution among institutions and instruments, and the degree of liquidity.

13. Demand for money.

a. Demand.

(1) What is economic demand?

(2) Elastic and inelastic demand.

b. Demand for money.

(1) Repeat comment about capital formation, then add consumption financing.

(2) Components of money damand.

(a) Ability to pay back principle and interest.

(b) Risk probability of repaying.

1 Collateral.

2 Credit performance.

3 Length of loan term.

4 Degree of payee commitment equity.

(3) Inelasticity and elasticity of demand.

c. Types of demand.

(1) Households.

(2) Businesses.

(3) Federal government.

(4) State and local government.

d. Demands which are particularly important to housing system.

(1) Housing example.

(2) Business example.

(3) Federal government example.

(4) State and local government example.

e. Demand for mortgage money.

(1) Qualitative and quantitative aspects of mortgage money demand.

(2) Normal effective demand.

(3) Assisted effective demand.

f. Relative strength of mortgage money demand.

(1) Summarize elasticity as announced in items b.(1) and 3.

(2) Explain inability to measure demand because of insufficient data.

(3) Refer to output section distribution of funds as allocated.

g. How is demand communicated?

(1) Purchase.

(2) Enquiry about.

(3) Information.

(a) Understand demand, consumer, and business.

(b) Locating and using sources.

(4) Intermediaries estimating demand.

(a) Reason for estimation.

(b) Types of estimation.

1 National estimates.

2 Local estimates.

h. Representing demand in the model.

(1) Aggregate representation the report of the President's Committee on Urban Housing.

(2) More responsive models — Factors to be considered.

Output is obtained from demand section when you know objectives of demand and know historically in what ways the money has been supplied in the past.

Demand. What is the definition of demand? Economic demand is made up of two components: (1) the desire to have some commodity and (2) a willingness (implies ability) to pay for. Demand is a schedule or curve representing a consumer's willingness to purchase varying amounts of a commodity at differing prices. Hence, one may be willing to purchase quantities of steak at a low price and progressively smaller quantities at progressively higher prices. Obviously, there will be limits to ones willingness to buy steak. On one hand, one will stop buying steak no matter how low the price goes when one surpasses his ability to consume it or run out of friends to treat. One the other hand, one will stop buying steak entirely when the price gets high enough.

Elastic and inelastic are terms which describe quality of demand; the slope of the demand curve. A relatively inelastic demand curve has a very steep slope; i.e., it will approach the perpendicular as zero demand is approached. This means that the price can be changed radically without affecting the quantity to be purchased. An alternately elastic demand curve

is flat near zero demand. It indicates the quantity a consumer will purchase in very responsive to even small changes in price.

Scarcity. Scarcity is an economic concept which has two components: (1) that human wants are basically insatiable, and (2) that resources (land, labor, capital, and entrepreneurship) required to supply those wants are always limited in the short run. Some thought will confirm the reliability of these assumptions thus far in human history. The combination of these assumptions results in scarcity. When unlimited wants for resources are combined with limited resources available, the result is scarcity of resources. Production carried on with scarce resources can only be expanded in the short run by a more efficient allocation of resources and in the long run by incremental expansion of resources. Once resources are most efficiently utilized, no further aggregate production can be achieved in the short run. Increased demand (which may be caused by expanded money supply) at such a time will result in inflation; i.e., prices will increase with no corresponding increase in production.

Demand for Money Condition. The ability to pay for a good does not necessarily imply that the total price of the product is paid from current income or accumulated savings. Money can be and is borrowed to finance the purchase of residences. This practice is nearly universal in the United States; hence, the demand for mortgage money. The demand for money as with other commodities implies both the desire for money and the ability to pay for it. Ability to pay for money has two facets:

1. That the borrower can afford to repay out of his income both principal and interest over some period of time (20 percent of income).

2. A probability that he will continue to be able to make his payment for the entire period of the loan or that the lender can recover his principal.

One means that the financial intermediaries use to reduce the probability that the principal is repaid to require the house as collateral for the loan which is a part of the definition of the mortgage as a financial instrument. The intermediate thus will obviously be interested in the resale potential of the property. Two factors bear on resale:

1. The prospect for the continued physical well being of the neighborhood.

2. The economic prospects for the city and/or region.

3. The liklihood that the house will continue to be in demand (anticipation of changes in consumer tastes).

In addition, the intermediary is interested in the liklihood that the consumer will continue earning adequate income over the life of the mortgage. Hence, the intermediary is interested in the following:

1. The age and health of consumer.

2. The type of occupation.

3. The consumer's credit behavior in past.

The terms of a conventional mortgage reflect the intermediaries judgement with respect to these aspects. Typical terms might be as follows:

1. 20 to 25 percent owners equity.

2. 75 to 80 percent mortgage value.

3. 20- to 25-year terms.

Demand for Funds. Households use funds for consumer durables, automobiles, and residences. Demand for small items tends to be inelastic because purchases are paid for in monthly payments. Hence, changes in interest rate cause relatively small changes in monthly payments. The greater the cost of the item relative to income the more elastic demand for that item, particularly where the item is not a necessity or can be replaced by a cheaper commodity which performs some function; hence, a worn out washing machine may be reconditioned for a fraction of the price of a new one or a used auto may temporarily put off the purchase of a new one.

Businesses demand capital for plant, equipment, and inventories. They use these items to increase the productivity of the production process. It is argued that their demand for capital is relatively inelastic because even high interest rates produce charges which are small compared to annual depreciation, and machinery is necessary to capital intensive technology. Businesses are not entirely insensitive to changes in interest rates, but it may require other economic circumstances rather than changes in interest rate to cause a shift in a given businessman's demand for capital.

The federal government normally does not borrow heavily except in crisis circumstance such as war or depression. Itsdecisions are determined primarily by the nature of the emergency rather than the cost of capital. The demand is hence inelastic.

State governments, local governments, and public-sponsored corporations demand capital to build public works such as highways and schools. The costs of interest will be paid or guaranteed by future budget. Often these investments must be approved by voters; hence, this demand is fairly elastic.

The normal effective demand for mortgage money is the sum of money demand by all consumers who would qualify for conventional mortgages at respective interest reates.

It has been in the past adjudged by the people through the Congress that housing does not have enough priority in the financial markets when expressed by normal effective demand. Congress has affected the priority by several means. One of these is by enacting legislation which affects primarily the qualitative aspect of demand. FHA mortgage guarantees are good examples of such governmental manipulation of demand. They affect the demand in the following ways:

1. The government through the FHA assumes the bulk of the risk associated with making a mortgage by guaranteeing that the lender will get back his loan.

2. Since this risk has effectively been removed from the lender, his other guarantees in the terms of the mortgage have been liberalized such that 10-percent equity and 35- to 40-year terms are not uncommon.

3. This development affects the quantitative aspect of demand by lowering monthly payments required for respective mortgage amount; hence, expounding effective demand.

It should be noted that FHA mortgages have legislated interest rate limits. Hence, in periods when market interest rate exceeds FHA limits, the demand made effective by these provisions becomes noneffective.

Other government programs directly affect the quantitative aspect of demand by subsidizing interest rates, thus reducing monthly payment required and income required.

Federal Reserve System (Part of the Interior Mechanism)

1. Structure.

   a. Board of Governors.

   b. Federal Open Market Committee.

   c. Federal Advisory Council.

   d. Federal reserve banks.

   e. Member banks.

2. Objectives of system.

   a. Stability.

   b. Growth.

3. Functions reserve banks perform.

   a. It holds a large part of the reserves of member banks.

   b. Advances funds to member banks, thus performing as a check.

   c. Collects all checks on member banks, thus performing as a check clearinghouse.

   d. Audits the member banks.

   e. Acts as banker for the federal government.

   f. Regulates the amount of required reserve which will be held by member banks.

4. Federal reserve tools for accomplishing its objectives.

   a. Open market operation.

   b. Rediscount rate.

   c. Required reserve.

   d. Example.

There is some question as to how much of the Federal Reserve System's structure and prerogative belong in our model of the money system. For purposes of this effort, all of the Federal Reserve System will be represented in the money system. The only inputs from outside the money system to the Federal Reserve System are as follows:

1. Authorizing legislation.

2. President's appointment of board members.

3. Funds involved in treasury to Federal Reserve transactions.

4. Information about the state of the economy.

The outputs leaving the system directly from the Federal Reserve are as follows:

1. Funds involved in transactions with the treasury and foreign governments.

2. Information about the state of the money system. The interactions between the Federal Reserve System and the other elements in the money system occur primarily through the member banks.

Regulation. National banks are subject to inspection by United States Comptroller of the Currency.

Banks

1. Importance of banks.

2. State bank.

3. National Banks.

4. Total 13 434 in 1962.

5. Members of Federal Reserve System.

6. 4500 national, 1568 state.

7. Holding 84 percent of demand deposits in banks.

Federal Reserve System.

1. 12 regional Federal Reserve banks.

2. Each regional bank owned by its members.

3. Each bank run by a nine-man board.

4. Six elected by member banks and three by the Board of Governors of the Federal Reserve. One of Board-appointed members serves as president.

Function.

1. Bankers bank — Each bank holds reserves that member banks are all required to maintain.

2. Do not accept deposits from individuals.

3. Banks are not run to earn a profit, mainly to accomplish public goals.

4. Command of entire system — Seven-member Board of Governors appointed by President for 14-year terms, confirmed by Senate.

5. A new member appointed every other year.

6. Left free to carry out law by its own interpretation with occasional report to Congress.

7. Federal Open Market Committee composed of seven board members plus five of regional bank presidents chosen in rotation.

8. Controls purchase and sale of government securities primary purpose of which is to control money supply.

9. Federal Advisory Council advises Board on monetary policy.

Functions.

1. Hold collective reserves of member banks.

2. Use reserves to support members in emergencies.

3. Clearinghouse for all collecting all checks on member banks.

4. Audit member banks.

5. Acts as banker for Federal Government.

6. Regulates amount of required reserve which must be held by member banks.

Sources of a banks funds:

1. Owners equity.

2. Deposits.

Uses of banks funds:

1. Cash reserves — Held in vault or Federal Reserve.

2. Loans to individuals and businesses.

3. Financial instruments, government bonds, and mortgages.

4. Required reserve quantity that must be held according to regulations.

5. Excess reserve is difference between required reserve and cash reserve.

Banks can create deposit by making loans. They may make loans equal to the amount of their excess reserves. Thus, individual banks can expand their deposits by the amount of their excess reserve. All reserve bank members may do this successively. Hence, the maximum deposit created is much greater for the system than for the individual bank. In fact, the deposit creation potential for the system at a given time is equal to the total excess reserves divided by the reserve ratio $(D = E/r)$.

Objectives of Federal Reserve System. No clear statement of objectives in authorizing legislation exists. The objective is perceived as stabilizing the economy; needs education and clarification. Federal Reserve has assumed the added objective of encouraging a high growth rate with a minimum of inflation. Stabilization plans are to avert depression and inflation.

1. Averting depression:

a. Symptom — Low level of investment.

b. Solution — Federal Reserve can expand excess reserves in member banks by reducing reserve requirement ratios.

c. This will enable banks to create new deposit; hence, enable them to extend credit to new customers and/or lower interest rate.

d. Indented result:

(1) Federal Reserve creates excess reserves.

(2) Member banks expand loans.

(3) Member banks lower interest rates and increase availability of loans.

(4) Investment and government spending increase.

(5) Net National Product rises.

The preceding means the Federal Reserve has to implement a policy:

1. Open market operations.

2. Control of the rediscount rate.

3. Control of reserve requirements.

4. Moral session.

5. Control over marginal requirements.

Open-market operations: Purchase and sale of government securities by Federal Reserve. Purchase of privately held government bonds increase reserves and excess. Reserves of member banks thus creating further bonus for creating loans and deposits; sale of the government securities by the Federal Reserve results in the opposite.

Rediscount rate: A member bank needs cash so it may sell short term paper to Federal Reserve at an interest rate determined by the Federal Reserve; i.e., rediscount rate. There is no physical causality involved in this relationship. Apparently, member banks consider it a signal of Federal Reserve attitude about credit. The rate of interest charge by member banks to its customers is correlated with the rediscount rate. Rediscount rates are determined by each Federal Reserve bank, subject to approval by Board of Governors.

Reserve Requirements. Federal Reserve can change reserve requirements according to Table 11.4 of Reference V-8. This tool is used infrequently because of the drastic effect it has on the operations of member banks.

Function of the Reserve Banks. The functions of reserve banks are summarized as follows:

1. It holds a large part of its member banks' reserves.

2. It advances funds to member banks needing cash.

3. It collects all checks on member banks, thus performing as a check clearinghouse.

4. It audits member banks.

5. It acts as banker for the Federal Government.

6. It regulates the deposit creating potential of member banks; hence, the supply of money.

Structure of the Federal Reserve System. The structure of the Federal Reserve System contains the following elements:

1. Board of Governors.

2. Federal Reserve banks.

3. Member banks.

The Board of Governors are the system's managers. It is a seven-member board. Each member is appointed by the President for a 14-year term, subject to confirmation by the Senate. Accenting the Board are two important committees: (1) The Federal Open Market Committee which controls the reserves purchase and sale of government securities, and (2) the Federal Advisory Council which advises the Board on monetary policy.

There are 12 regional Federal Reserve banks. Each bank is owned by its member banks and operated by a nine-man Board; six are elected by member banks and three are appointed by the system's Board of Governors.

The member banks may be nationally or state chartered banks. There are approximately 6000 member banks holding approximately 85 percent of the demand deposits currently in banks.

Mutual Savings Banks. Presently, Mutual Savings banks are chartered only under state law. Limitations are as follows:

1. Restrictions on composition of portfolio.

2. Loan-value ratio.

3. Maturity of mortgages.

4. Some restrict dollar value of mortgage.

5. Geographic restrictions.

State-Chartered Commercial Banks.

1. 80 percent of property value for loan.

2. Maturity of 25-year loan.

3. Limit aggregate share of banks investment portfolio in mortgages.

4. Geographic restrictions.

Insurance Companies

1. Unlimit maturity.

2. Loan-value ratios of 75 percent.

Pension and Mutual Funds

1. Authority.

2. Counselors do not favor mortgage.

3. Feel cost of making mortgage too high.

Factors Influencing Lending Propensities of Financial Intermediaries

1. Tradition.

2. Charter requirements.

3. Tax laws.

Commercial Bank

1. Federal laws restricting down payments maturities limiting terms of construction loans currently 25 years at 80 percent.

2. Only certain kinds of paper may be discounted by the Federal Reserve. These papers do not include federally insured and guaranteed mortgages.

Savings and Loan - Federally Chartered

1. Loans made mostly in 100-mile radius of home office.

2. Current FHLBB regulation interpertant of this law are the following:

a. Limits of any single-family mortgate of $ 40 000.

b. Mortgage ceiling of $ 31 500.

c. Loan-value ratios limited to 90 percent on one-fifth of the companies' loans and 80 percent on the remainder.

3. Limiting of interest rates to the maximum permitted in the states, or 8 percent if no maximum is in effect in state, and do not allow trustee function.

Figures V-4 through V-8 illustrate a beginning step in the development of the complex intra-actions of the capital functions that has been outline in detail in this section.

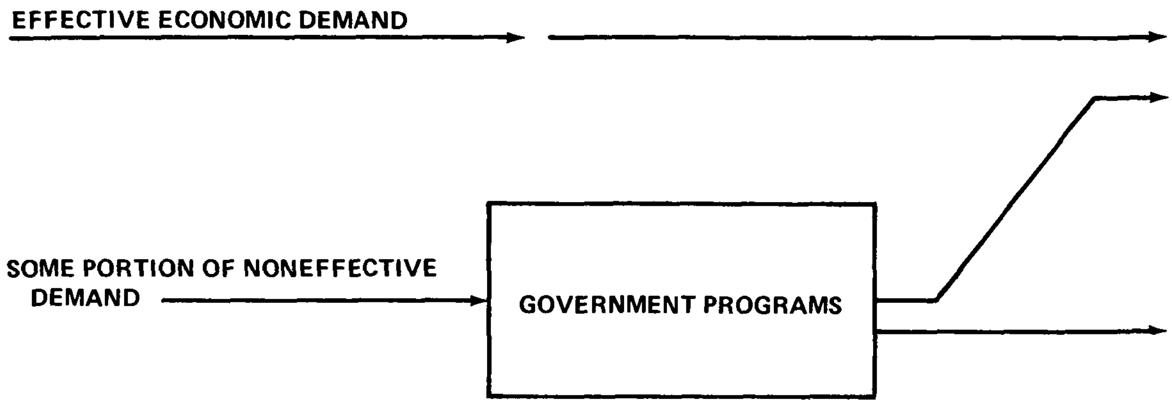


Figure V-4. Noneffective demand becoming effective.

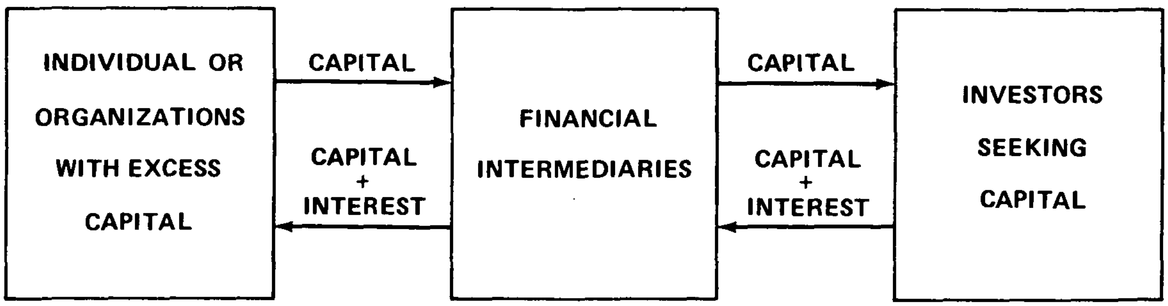


Figure V-5. Conceptual model of money function.

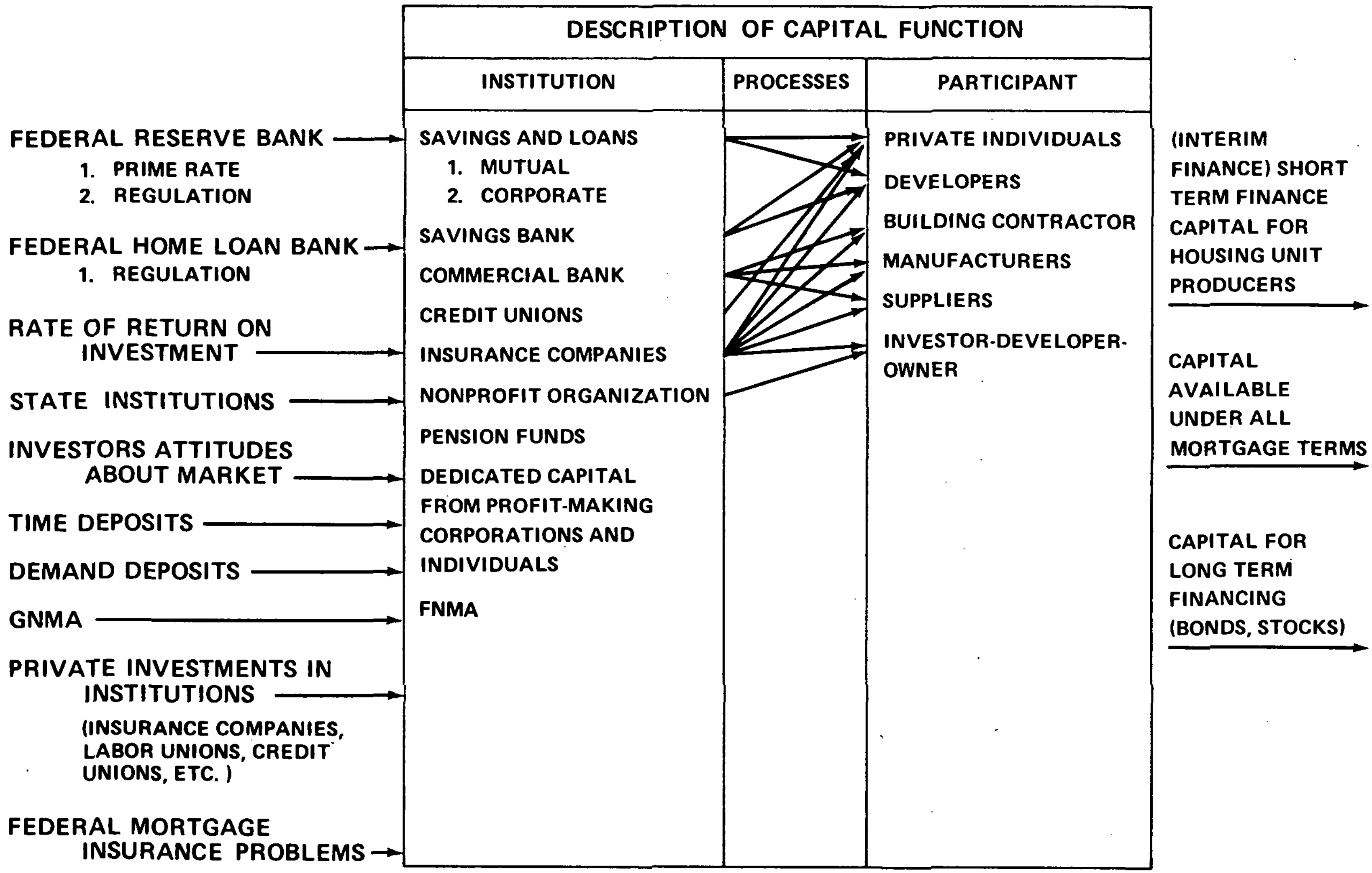


Figure V-6. A representation of the capital function.

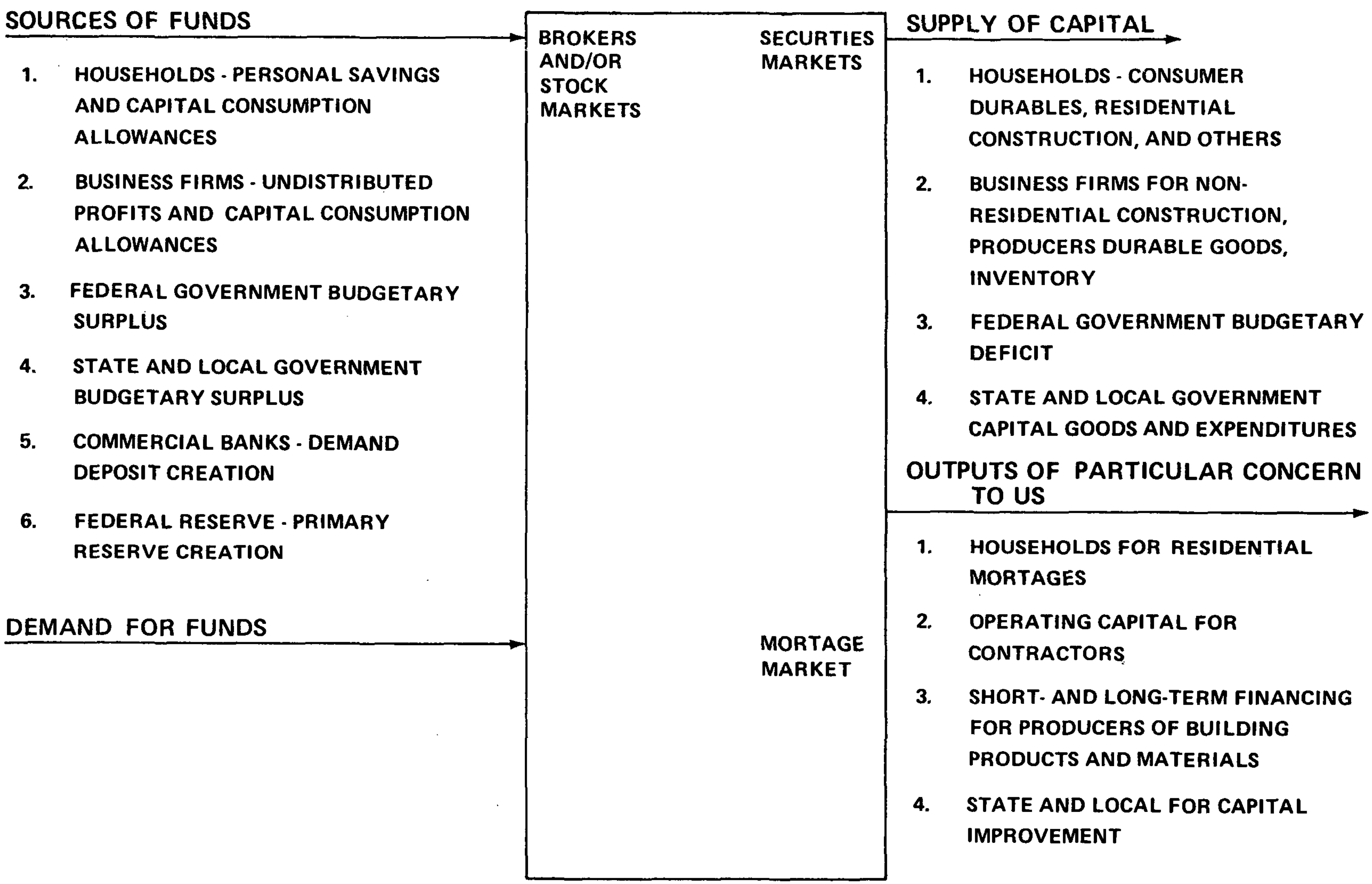


Figure V-7. Capital function.

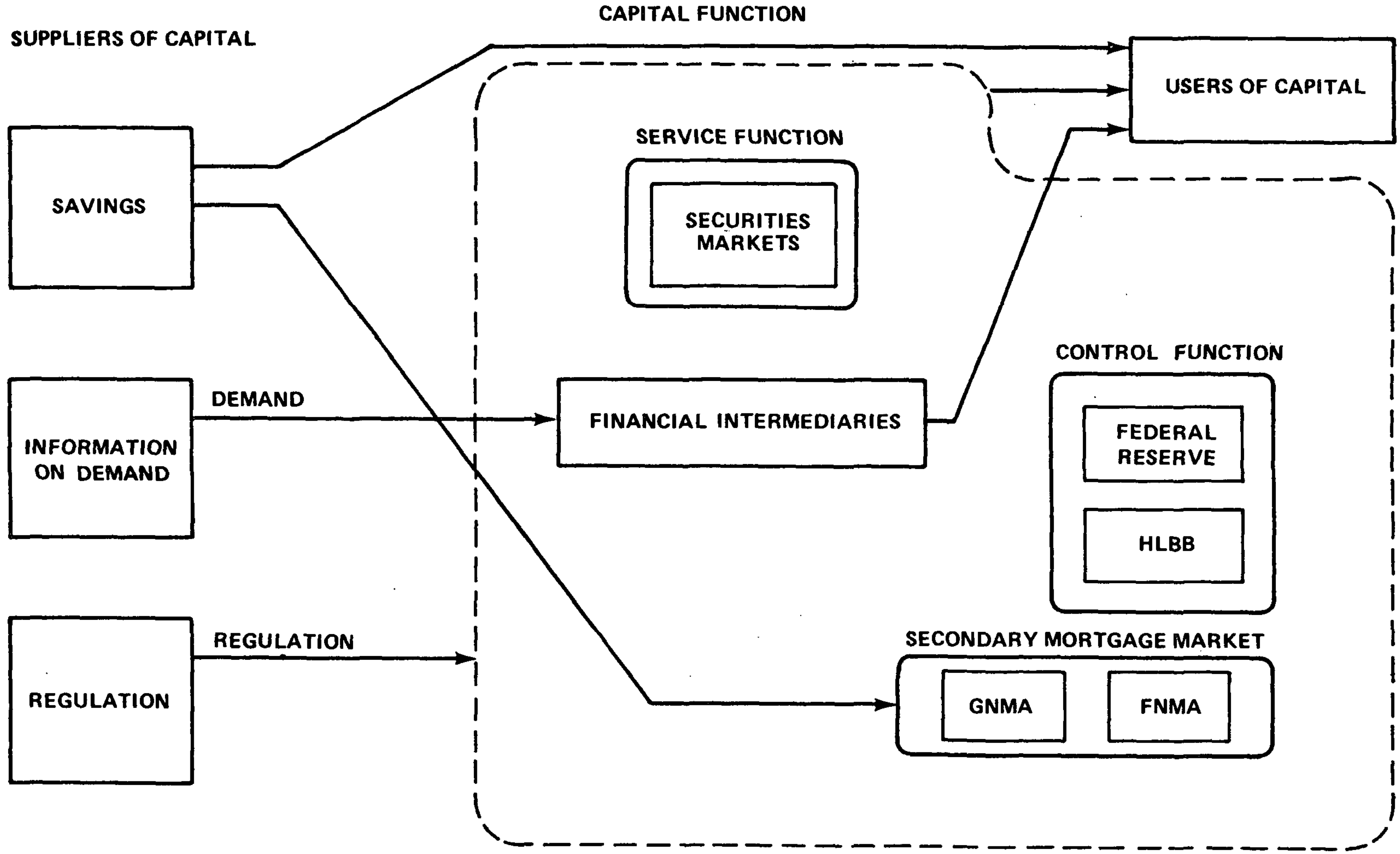


Figure V-8. Representation of capital function.

REFERENCES

V-1. The Report of the President's Committee on Urban Housing. A Decent Home, Edgar F. Kaiser, Chairman.

V-2. Community Builders Handbook. Urban Land Institute, 1968, J. Ross McKeever, ed.

V-3. Casey, William J.: Real Estate Desk Book. Institute for Business Planning, 1969.

V-4. Building the American City. National Commission on Urban Problems, Paul M. Douglas, Chairman, Part IV, pp. 323-416.

V-5. Chapin, F. Stuart, Jr.: Urban Land Use Planning. University of Illinois Press, Urbana, 1965.

V-6. National Land Use Policy — Hearing Before the Committee on Interior and Insular Affairs. U. S. Senate 92nd Congress, 1st Session.

V-7. Netzer, Richard: Housing Taxation and Housing-Policy. Brookings Institution, Washington, D. C., 1967.

V-8. The Report of the Presidents' Committee on Urban Housing. A Decent Home, Technical Studies, vol. II, Edgar F. Kaiser, Chairman.

BIBLIOGRAPHY

Campbell, M. Earl: Identifying a Highway Problem. Traffic Quarterly, October 1967, p. 543.

First Interim Report. Auburn-MSFC Design Team, July 1, 1971.

Fragmentation in Land-Use-Planning and Control. Research Report No. 18 of the National Commission on Urban Problems, Paul M. Douglas, Chairman.

Meyerson, M., and Benfield, E: Politics, Planning, and the Public Interest. Planning, The Free Press, Glencoe, Ill., 1955, p. 269, Chap. 10.

Milgram, Grace: The City Expands. HUD, Institute for Environmental Studies, University of Pennsylvania, Philadelphia, Pennsylvania, March 1967.

Milgram, Grace: Urban Housing. Margy Ellen Meyerson, The Free Press, New York, 1965, p. 373, Chap. VII.

Technical Information for Congress. Report to the Subcommittee on Science and Astronautics, U. S. House of Representatives, 1st Session, 92nd Congress, revised April 15, 1971.

Zoning Controversies in the Suburbs: Three Case Studies. Research Report No. 11, Ibid.

CHAPTER VI.

CONSIDERATIONS OF ENVIRONMENT AND NATURAL RESOURCES

Page Intentionally Left Blank

CHAPTER VI. CONSIDERATIONS OF ENVIRONMENT AND NATURAL RESOURCES

Introduction

The project groups separated into investigation task groups early in the program. One such group was concerned with environmental, ecological, and natural resource considerations. The members of this group were not knowledgable in these fields but they attempted to review the impact of these fields on the housing industry. The contents of this chapter are the results of this review.

Preliminary studies indicate an inadequate understanding of the effect that physical, biological, and chemical exploitation processes have on the various natural resources. Ecological balances that have required centuries to achieve are disrupted in a few years. Every function of our society has some effect on ecological balance. Therefore, a comprehensive study of housing must include consideration of the environmental effects generated by various proposed solutions.

In the case of the lower-income population groups, the point may be made that housing is not the root cause of the various problems with which it is often associated and can therefore only influence those problems in an uncertain way. In this regard, the efforts that are being voguishly pursued by researchers to provide peoples' needs are lacking in terms of opportunities for positive contributions to peoples' development. Great capabilities in physical technology exist, but until these can be defined desired performance objectives that are integrally related to the human development may very well be compounding our problems. It would appear then, that an essential beginning would be to generate an opportunity for this country's people and thereby foster development of individual capability, of responsibility, and of personal reward. If new towns can help in this direction, then the programs should be designed to provide opportunities for those deprived of human development as well as in housing.

In short, the scope of new town developments embodies social and behavioral components that are not adequately understood, especially with low-income, undereducated population groups. Private new town developments planned with a narrow social philosophy are less risky.

With respect to an information system to assist in national policy and decisionmaking, more thought should be given to the ones the information system would principally serve. The system must be user oriented. It has been said that all principals in the housing system could have access to the data; however, since there are obvious differences in information needs required by each of the users, the question arises if a general system would be best for all. For example, the Office of Economic Opportunity operates Fair Housing Centers and the experience of these centers indicates that a considerable part of the problem poor people face in dealing with housing markets is lack of information. The neighborhood service components of the centers have found many poor people eager and willing to find housing closer to job opportunities but unaware of the existence of possibility of making such a move. Many poor people are equally unaware of the administrative and legislative assistance available to assist them with problems in this area.

If there is to be the development of an information system for Congress, it should take a critical look at the suggestion "control." In this context, two quotes are cited:

> "...With strong local leadership, with earnest and continuing federal cooperations, with a recognition that we have only begun to tap the enormous energies of private enterprise in meeting public problems, we can have a rebirth and renewal of America's cities."
>
> Richard Nixon
> Aug. 1, 1968
>
> "Private enterprise can best provide the muscle, the talent and the major effort -- when there are opportunities to earn reasonable profits and to function at maximum efficiency."
>
> "Private enterprise has demonstrated it can build subsidized housing with speed, efficiency and economics. It must participate fully, along with non-profit sponsors and eligible public agencies, in the development of such housing."
>
> The President's Committee
> on Urban Housing
> (Kaiser Committee)

It should be clear that the government does not intend to control housing. It is believed that government would like to control the outcome of their programs as much as possible and that the realignment of HUD by Romney is an effort in that direction. An interesting statistic for reflection is that the new housing program initiated by the government during the decade 1960-1970 amounted to approximately 4 percent of the private production during the same period.

Accommodating the housing needs will require a concentrated effort and it should be an exciting challenge. Just to take advantage of the new technology can be meaningful to society. If the rate at which the living are able to implement what now is possible, improvements in most every aspect of life can be made.

To fit all that is possible into the existing systems and modes, some of which are almost totally obsolete, is only a part of the problem. The effort required to help people help themselves staggers the imagination. People are slow to change. The institutions to which he is subservient are even slower to change.

Essential needs of people have not materially changed within the time of recorded history, but the scope of available pleasures has become almost unlimited. Distance is no longer the problem it once was. Transportation systems have brought the world closer together.

To make all things available to all people is not likely to occur in the foreseeable future but many needs can be met. Choice in the more affluent nations is a factor which has promoted individual initiative. When basic needs are met and the mind is free, then one can respond to desires and creativity.

Living Space

Presently, it is not possible to predict just what should be the responsibility of this effort in housing or just how far it should go to meet the needs of every individual. Living space as it is now conceived could include everything from space frames where many units could be stacked atop one another in new cities which might require a considerable part of existing open areas, areas which ultimately may be needed for food production.

The decisions which will be required can be vital to the many aspects of human welfare. Many factors must be considered, but the question of human needs versus limited materials is vital. There are those who think planned space is necessary. As yet this is not generally the case in the Unites States, though some countries may have reached this point.

Transportation systems are consuming ever-increasing areas of land. This cannot continue at such an unrestricted rate for very long. There must be concern for materials and resources that are to be available for the future generations of mankind.

Through proper planning, much of the presently unusable land can be reclaimed for living space. This is one approach to conservation of the precious land. One aspect of an affluent society which is using too much of the valuable space is trash yards. Much of these materials can be, and should be, reclaimed and recycled.

Considerations

To develop a reasonable plan of attack on any problem, information must be gathered to clarify the problem and to aid in determining viable solutions. The first objective of this task group was to retrieve as much information as possible about the environmental, ecological, and natural resource aspects of the question. With limited available data, it was possible to suggest types of information needed to provide usable tools for decision-making in the housing area. Some considerations that may be used as tools to develop a mechanism of decisionmaking in the housing industry are listed below.

Raw Materials. Raw materials, for the most part, are limited in quantity. There must be a logical plan for establishing depletion and recycling rates. The processing of raw materials should be engineered to minimize or to prevent deterioration of the environment. For example, according to the Statistical Abstracts of the United States [VI-1], commercial production of timber is possible on about two-thirds of our 750 million acres of forested lands. Of this amount, more than two-thirds is privately owned with the balance under some form of governmental control. In 1968, the United States produced over 37 billion board feet (the balance being imported).

Most of the production (approx. 90 percent) is of the soft wood varieties, and a large part of that is used in the construction industry. At present rates of use, the United States is growing sufficient stock to more than replace that which is being cut. In fact, the present stock is enough to last 58 years at the present rate of use with no additional amounts being grown.

Reconstitution. With the present technical knowledge and that knowledge that may be expected in the future, there is a good chance that much progress will be made in reconstitution of our resources. It is known that all elements can be converted to energy of some form. Then, the ultimate raw material is energy. A look at the energy resources of the world will give some idea of the potential that is available. Estimates of available energy in the world system include 4000 billion-billion Btu per year from the sun of which 1 billion-billion Btu is consumed by plants to power photosynthesis. Recoverable coal and petroleum sources indicate 231 billion-billion Btu. But, if means are found to make fusion reaction practical, a virtually unlimited sources will be available. For example, the energy in the form of deuterium in the ocean is estimated at 12×10^9 billion-billion Btu. The energy is there. The means to extract it are still missing, but they will be found.

It is felt, in many quarters, that some means of slowing the spiralling growth rate of energy usages must be found.

According to G. C. Hann: "Between now and 1980 the domestic petroleum industry is being called upon to find 55 billion barrels of oil plus 260 trillion cubic feet of gas."

"If the world energy demand increases by 4 percent per year, compounded, based on modest population (GNP growth), the reserve needed is then equal to cumulative past production plus 10 times the current annual production rate. With fossil fuel alone, we may be in trouble after 2050; adding cheap uranium, we are in trouble after 2070. After 2100, man-made energy release is 1 percent of natural solar influx and the waste heat disposal problems have to be solved [VI-2]."

Regulations concerning the national resources which may become scarce are often under some control of vested interests. Many of these laws are obsolete, poorly enforced, abused, and, in certain cases, ignored completely. Legislatures must enact reasonable laws and guidelines to protect the environment and to conserve the natural resources. New methods must be developed to implement these laws.

In the near future, intelligent people must face these problems, otherwise that which we consider worthwhile may be lost. Those who are now aware of the consequences and who are in positions of power or persuasion, must take the leadership in the fight to conserve the standard of living in this country and improve it in the less fortunate countries.

New materials such as plastics and fiber combinations or products, which at one time did not seem to lend themselves to building, are being reconsidered and in many cases can be used to advantage. Real and esthetic qualities are improved as a result of research and innovation.

Fireproof materials as warranted by new uses are becoming available on an ever-increasing scale. It is now within the scope of most new construction. Walls can be fabricated with most conceivable appliance and structural needs cast in place. These may be fireproof within allowable limits and have the structural strength to meet needs far beyond usual requirements.

Research and Exploration. Nonregenerative materials may be replenished in two basic ways. First, there is the development of new methods of extraction from their original state, and second, there is the location and development of new sources of the material. There is a continued search for new ways to incorporate materials in different ways into the housing industry. Industrialized housing calls for many innovative uses of materials. Relaxation of local building codes or changes in standards or specifications will inject a stimulus that will further research tremendously.

Wood can regenerate itself or is regenerated with the help of conscientious men. Much of the other building material is nonregenerative. Some is at least partially recoverable, but so far this is done only on a small scale. There are vast quantities of used, but recoverable, minerals and metals in the soil and sea. Expedience may dictate the discovery of economical means for recovering these materials.

New methods for locating and policing our reserves have been developed or are in the development stage. One is through the use of NASA technology and satellites orbiting the earth. Techniques are being refined in many research centers of the country. First indications are that these will greatly enhance our ability to locate and produce efficiently the great quantities of products needed to meet our housing and standards of living needs.

Inventory. To know the prospects for future development, a continuing inventory of available supplies and known national and international reserves must be considered along with consumption rates. This inventory should be as accurate and as up-to-date as possible.

Most producers are advertising and selling their wares as if the quantities were unlimited. The energy people desire that the consumer increase his uses both in quantity and kind. The affluent society eventually will have to set limits on its goals. However, there is no reason to believe that these limits would cause a drastic change in the "standard of living."

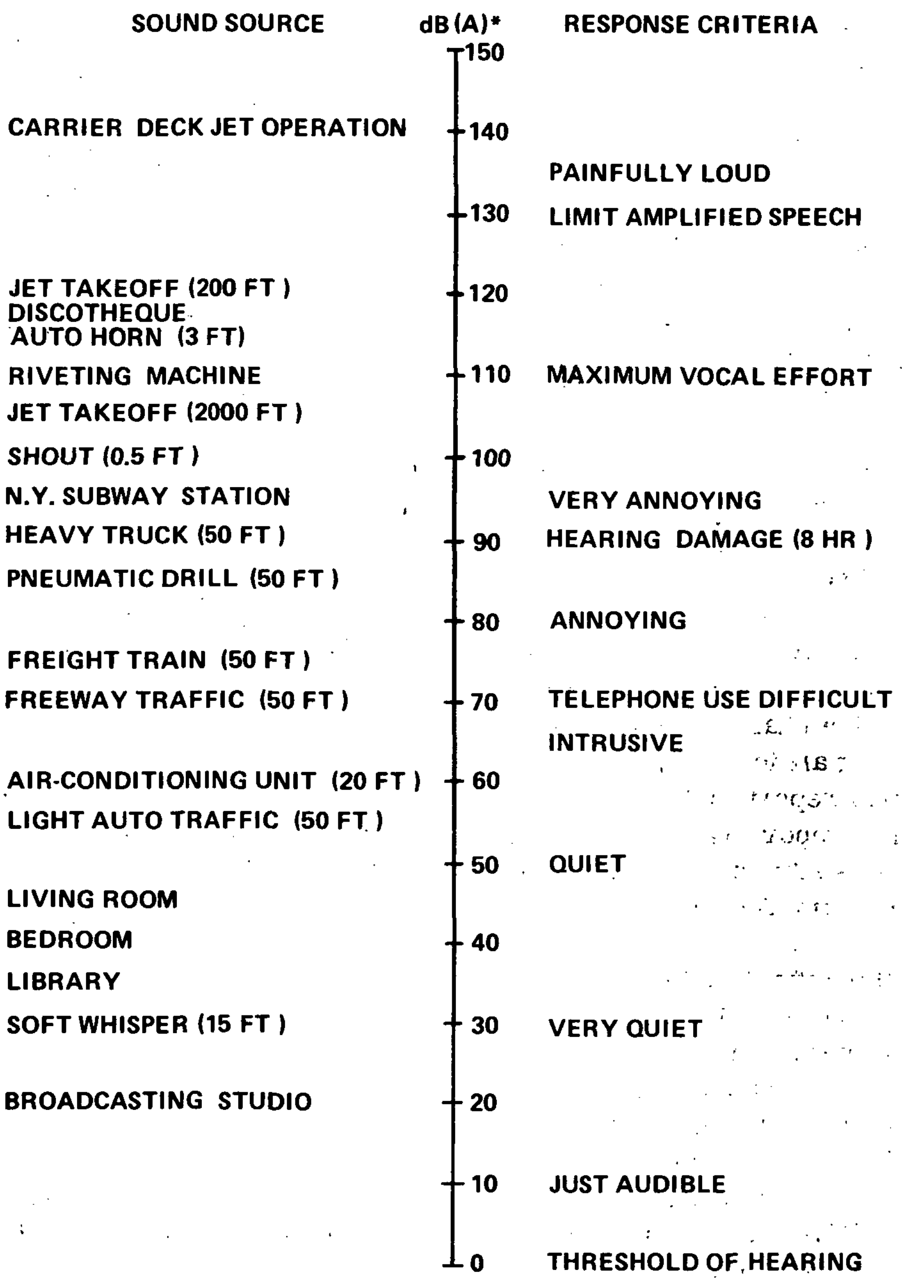
Industry. Industry must be allowed to experiment with new materials and methods and if they are feasible and meet the performance requirements, be allowed to incorporate them in new production. Some areas where additional toil is needed is in sound proofing or reduction. Figure VI-1 shows how normal and abnormal sounds may affect us.

Ecological Considerations. This entails the ability to understand and predict the effect on the world evnironment of the physical, chemical, and biological processes resulting from decisions of governments, industries, and individuals. Since man's beginning he has left waste where he has been. The housing industry must be fully aware of the social and environmental impact of their business.

In recent years, there has been much activity on the part of fundamental environmentalists. This is really not a new movement but it has tended to focus a great amount of governmental activity in developing regulations and guidelines. In most cases, however, these have been piecemeal, impinging only on small and fragmented parts of the total problem. There has been corporate resistance from some quarters and some self-policing.

The corporate profit aspect and the ecological concern, however, may not be incompatible. A recent study, to be reported this fall and previously found in a report from the Council on Economic Priorities, indicates that the most successful companies in the pulp and paper industry are the very ones ranking highest in protecting the air and water environment in which they operate. The benefits of providing a good environment record include lower operating costs in areas such as labor, health insurance, maintenance, local taxes, legal fees, and fines. Another benefit is that "clean" companies may have lower costs in raising capital because a favorable corporate image may command slightly higher stock prices and lower borrowing costs. Also, there is some indication that the company with a notable record

WEIGHTED SOUND LEVELS AND HUMAN RESPONSE



*TYPICAL A – WEIGHTED SOUND LEVELS TAKEN WITH A SOUND-LEVEL METER AND EXPRESSED AS DECIBELS ON THE SCALE. THE "A" SCALE APPROXIMATES THE FREQUENCY RESPONSE OF THE HUMAN EAR.

Figure VI-1. Noise chart.

for social responsibility may earn public acceptance and trust for its products and pricing.

The housing industry is a large user of our natural resources and in many cases an ecological albatross. Little has been considered by many builders of the affects of stripping the land to build great housing developments. Once-lovely wooded areas have been decimated so that large-scale housing methods will not be reduced in their "efficiency." In most cases, these have not reduced substantially our supplies of usable timber, but they have detracted greatly from the esthetic aspects of the area. It takes many years of careful naturing to redevelop even a semblance of the prior beauty.

Much of the material available regarding environmental considerations is emotional and based on partial facts ("The Rape of America;" "The Greening of America;" and articles in the popular periodicals and newspapers). This emotional approach has served an important role in awaking the public to the significance of our abuse of nature. Now that the public is aware, it is time to initiate actions based on factual knowledge. The National Environmental Policy Act created the Council of Environmental Quality, an agency which has the charge of coordinating all environmental quality programs and in reviewing all federal programs affecting environment. The Council's first annual report in August of 1970 is an attempt at providing this factual input. The report was written with incomplete and inadequate information, yet it represents an important trend toward that quality of information required by any decisionmaking agency such as Congress.

Elements of the environment are at present subject to adverse conditions, some of which are of such magnitude that they are almost beyond the control of man. Earthquakes, lightning, severe wind, storms, tidal waves, floods, pests, and accidents (such as air crashes) are often beyond the ability of man to foresee and prevent. Standby or emergency measures to meet immediate service needs are often late and are frequently inadequate. Planning for these conditions must be a matter of design in the total plan of environment. Efforts are being made to control some aspects of nature at least in the areas of predictability. Weather, extreme quakes, and tidal waves are some of the things which can be monitored or sensed by early warning systems. Insidious problems (i.e.,those which seem to develop almost unnoticed) must be attacked before they reach the serious stage. Some of these problems are pests, noise, and filth. The ability to tolerate many annoyances seems to be indigenous to certain elements of society; i.e., they put up with things that seemingly no one cares enough to be concerned or try to do something about. As communities grow and as open areas slowly diminish, these

problems persist causing trouble, expense, friction, and concern. To say that solutions are the function or responsibility of any one particular agency or group is as wrong as allowing such to exist in the first place. Action must be expected of the individual citizen if a pattern is to be set. The trend should be to protect the environment. Appealing to the "self" is to invite responses of the individual. To impose rules or restrict privileges is seldom the answer when cooperation is desired; therefore, the individual must be invited to respond and accept responsibility.

When the real advantages are demonstrated and documented, people may become accustomed enough to the better way that they may continue to maintain the new standards.

If there is involvement in the unexplored areas of man's needs, it can be most exciting. There must be voluntary cleanup of the environment. Car exhaust, sewage, and manufacturing processes which cause pollution must be reduced to tolerable levels. To allow such pollution to exist within our society is to ignore all hidden costs as regard health, cleanup, loss to economic growth, and any feeling of pride.

National Research Council of the National Academy of Engineering - National Academy of Sciences makes the following ovservations: "In studying solid wastes systems, the committee suggests that progress in the field of solid wastes management is unlikely to come from a massive breakthrough that will obliterate difficulties and simultaneously solve a wide range of problems. More likely, it will come from a series of step-by-step efforts that solve one problem at a time. Gains in the management of any single part of the system are likely to be small and undramatic. But in the aggregate, a series of small improvements, systematically applied, will bring substantial progress."

Thadani has stated: "Two hundred million people in this country presently generate over 3.5 billion tons of refuse each year. However, less than 200 million tons, or about 5 percent of this total generation, is ever collected [VI-3]. Agricultural, mining, and many industrial wastes form the part that is uncollected while solid waste from households and commercial establishments is usually collected, at least close to urban centers. The situation in rural areas fluctuates slightly.

The cost of solid-waste collection is by no means insignificant. Upwards of $4.5 billion are spent annually on solid waste collection and disposal. Of this, 75 to 80 percent, or between $ 3.5 and $ 4 billion, is spent on collection alone.

This makes collection the third most expensive item among all, community services, coming after schools and roads.

The collection function is highly labor intensive, so that a good 75 per-cent of this $ 3.5 to $ 4 billion is direct labor costs, with perhaps $ 0.5 to $ 1 billion going for collection equipment annually."

An economic feasibility study indicates that for most urban areas conversion of solid wastes may be the cheapest method of disposal.

Currently, there is no proven or practical technology to eradicate the slum or blighted area, though it may come.

To plan for even a partial solution, it is necessary to identify large urban areas that are considered blighted. Factors leading to blighted areas are crowded populations of limited education, lack of effective finance, and planning agencies. Some people are attracted to slums because of the following reasons:

1. To be near their own people.

2. To share ethnic language.

3. To secure common bonds.

4. To hide (limited personnel needs shelter).

5. For economical use of limited finances.

6. Because of fear and superstition.

The makeup and order of the people of such areas are a "neighborhood" leader, the family group, and a political representative for pressure. Often, blighted areas are of distinct ethnic origins, usually, Indian, Puerto Rican, Negro, Italian, and Mexican. Language is a primary factor in drawing them together. These areas are usually congested, prematurally obsolete (used with no concern for rehabilitation or development) "progress." Also, these areas must grow or expand.

The American Indian, Negro, Mexican, or any group which has suffered as a result of unfair practices resulting from prejudice, greed, or political pressure should belatedly be given a dignified place in society.

Area problems include poor sanitation and filth, crowding, no privacy, little shelter and protection, easily contracted disease, lack of medical care, high delinquency, and social disorder. Living units are usually dilapidated buildings or rural shanties of scrap lumber, tin, old brick, and anything that can be held together for protection from the elements.

The deprived, lacking proper quarters, move in on marginal lands, confiscating delinquent tax properties, or hillsides where titles are difficult to prove. Once entrenched, they become very hard to dislodge, soon making areas more congested and more subject to filth, trash, odors, noise, and most all forms of degrading environment.

Concern for the poor must go far beyond compassion. It will require an all-out assault on all aspects of education, economic, health, social, and ethnic considerations if the slums are to be eliminated.

To salvage a poor family and support it until it can be at a point considered to be self-supporting, we must consider the actual cost to society to allow a family to be poor, a slum dweller.

Conclusions

These are only a few of the factors which should be considered when developing a decisionmaking mechanism. These should be expanded and quantified to indicate their relative importance in the system.

The Environment and Natural Resources Task Group developed a list or statement of objectives which, if initiated, might help to answer many of the problems. To upgrade the human and natural environment, one should:

1. Establish pollution standards for all natural systems.

2. Provide enforcement power to maintain natural ecologies.

3. Require that cities and buildings be constructed only if damage to the environment is minimal.

4. Require that any built environment be sustainable by the host ecology.

5. Through a "Building Research Institute," encourage technologies and design concepts utilizing minimum materials and energy to create and maintain.

6. Provide substantial subsidies to foster and encourage mass-transit systems.

7. To provide realistic boundaries for cities to increase the efficiency of all civic services.

8. Update and replace codes and zoning ordinances to increase efficient use of land and materials.

9. Research human reactions to their environments.

10. Provide adequate education for all people with emphasis on natural resources and ecology and communications.

The people in need must be helped in a positive way. Finances and compassion are fine, but if the pride and dignity of the individual is to be maintained, it will take much more. Moving families into new modern homes will not bring about change or the incentive needed to make a personal gain.

There are cases of misuse of public funds where the poor or underprivileged have received funds to house, feed, and clothe themselves and then used these limited means to buy things that are considered luxuries even to the wealthy. There must be means to help the poor who deserve help.

Large-scale migrations to cities and consequently to slums can contribute to blight. Serious social problems are most often linked to the slum and poor areas. Yet, it is questionable whether the social aspects of apathy, powerlessness and such can be directly attributed to poverty. Poverty is a function of the individual, not of society. Social workers do become involved, but with limited funds they are ineffective. Private capital cannot clear and rebuild for low-income families under these conditions. For example, the cost to rebuild or tear down can be as much as \$ 500 000 per urban acre and from \$ 15 000 to \$ 25 000 per acre for accessible rural lands. Additionally, efforts to correct or renew are seldom effective in that no one has enough authority or drive to work toward improvement.

In current slum redevelopment programs, a local renewal agency acquires and clears the area and relocated the people. A developer is chosen and allowed to rebuild; the Federal Government pays three-fourths of the cost. Yet the factors of class structure, economics, design, and governemnt processes usually bypass undesirable neighborhoods, and, in fact, sometimes contribute to more degradation.

Blighted areas in the United States (particularly compared to those of India, China, Mexico, and some other countries as well) are considerably small. For instance, 60 percent of India's population live in slums. One and one-half million homes unfit for human habitation are located in four main cities of India, whereas, in the United States, the slums consist of less than 10 percent of the population. Some places have kept ahead of the problem. This is particularly true in Sweden and northern Europe.

The hidden cost of allowing slums to spread is likely to be more than the real cost of doing what should be done.

Until we evolve into a semi-utopian society, the idea of a humane environment may remain simply a pleasant thought peculiar to visionary individuals.

Depletion Rates. Depletion rates indicate the time that a supply of a resource may be expected to last. The industry must understand this and make their plans accordingly. Development of new methods and search for new sources of supply are but two of the ways than can counteract the depletion rate of a particular commodity.

Each day, newspapers, magazines, TV, and radio stress the depletion or scarcity of some forms of energy, or the potential pollution from the same. One recent newspaper carried side-by-side articles dealing with oil production. John G. McLean, President of Continental Oil Company and spokesman for the National Petroleum Council, which is developing policy options for Congress, states that there will be a sharp rise in the dependency on foreign oil and an acute shortage of natural gas if the government and industry policies are not altered. (This suggests he would prefer less government control.) He said that by 1985, imports of oil, about 75 percent from the Mideast, would reach 14 million barrels a day, which is equal to the total present production of the Mideast.

Next to this article was a statement by Interior Secretary Roger C.B. Morton that the nation may face a frightening energy scarcity in the latter part

of this century. He indicated that consumption of power from all sources would double by 1990 and triple by 2000. "But, that although we must find new sources of energy, the environment must be protected. We cannot continue to have such a large portion of the cost of energy borne by the environment."

Using 1957-1959 as an index, by 1968, our use of minerals had increased by 37 percent. At this rate, our use will more than double this figure by 2000.

In 1967, our market production of natural gas was over 18 trillion ft^3; this compares with proven reserves of 292 trillion ft^3. The use has doubled since 1955. During this same period, the proven reserve has increased from 223 trillion ft^3. How long we can continue to increase our known reserves is questionable. If no new sources are found, we could expect these reserves to be used by the end of this century.

Standards and Specifications. At present, these are often a deterrent to progressive development of new materials and methods and yet they are vital to maintain quality on the job. They should, however, be modified and updated to performance requirements rather than material requirements.

The establishment of standards would follow the information-gathering stage. These can be separated into two classifications: (1) those providing control and (2) the minimum level of acceptable quality. The concepts of these standards are not new because control standards regarding acceptable levels of nuclear radiation and minimum standards as applied to water quality exist. The standards should be flexible, allowing for improvements, and not under the control of vested interest groups as building codes currently are. Control agencies have already been established as independent agencies much like NASA. First, the Environmental Protection Agency would establish and enforce such controls for the Continental United States, and, secondly, the National Oceanic and Atmospheric Administration would be responsible for research and control of marine programs.

Competing Uses. Most materials of construction are in some stage of limitation. Minerals, particularly known reserves, are somewhat limited. Other users of these products will offer much competition. This could tend to cause a rise in prices — even to pricing out of reach of the housing industry.

This competition could also have the dangerous affect of reducing the reserves at a more rapid rate.

Technology. The present state-of-the-art in the housing industry has not made great strides such as have been seen in some other industries. Breakthroughs, even in components, have been at a minimum. Some of this lethargy has been because of the restrictive codes and municipal regulations, but much has been because of the method of operation of the majority of the industry.

Technological evaluation of processes and methods has had little meaning in this fragmented industry. Some larger producers have made inroads in this area, but the regular small builder is using much the same methods and materials that were used for many years.

Lack of information was frequently cited as a barrier to the establishment of an effective program. A survey and inventory of natural resources is an important first step in establishing national or global priorities. NASA is currently investigating methods of extending the remote sensing capabilities of satellites to aid in this survey and inventory process. It is not the intention to complete an exhaustive inventory but rather to establish a base of known sources that can be modified as additional discoveries are made. A major part of this survey would include consumption analyses. Greater emphasis would be placed on the analysis of scarce resources than on the abundant ones. Recycling and replacement efforts could then be directed toward the critical areas, and the critical areas should be more visible than they are currently.

Demand Influence on Price. Normally, an increase in the demand for a product which is somewhat scarce will drive the price upward. If a product is plentiful, this is usually not the case. As the materials of construction deplete some of our resources, it may be that prices will rise more rapidly. Recent price rises in the cost of housing materials are caused by several other economic factors, but even here there is a small amount of demand influence. Japan has been purchasing considerable American lumber for their plywood industry. Although most of this is returned to these shores, it still acts as another competition for the raw materials.

REFERENCES

VI-1. Statistical Abstracta of the United States, United States Bureau of the Census, 90th Edition, Washington, D.C., 1969.

VI-2. Wei, James: Future Prospects for Energy — Sources and Uses. University of Delaware Engineering Experimental Station Bulletin No. 6, April 1971.

VI-3. Thadani, Narayah: Solid Waste Collection Systems. Professional Engineer, vol. 41, Washington, D.C., July 1971.

BIBLIOGRAPHY

Back, Kurt W.: Slums, Projects, and People. Duke University Press, Durham, N.C., 1962.

Chapin, F. Stewart, Jr.: Urban Land Use Planning, 1965.

Clinard, Marshall Baron: Slums and Community Development. The Free Press, New York, 1968.

Feldmann, H. F.: Pipeline Gas from Solid Waste. Professional Engineer, vol. 41, Washington, D.C., July 1971.

Gershowitz, Harold: Rubbish: An Overview. Professional Engineer, vol. 41, Washington, D.C., July 1971.

Gude, Gilbert: The Solid Waste Problem. Professional Engineer, vol. 41, Washington, D.C., July 1971.

Marine, Gene: America The Raped. Simon & Schuster, New York, 1969.

Public Law 171, 81st Congress, 1st session (July 15, 1949), Housing Act of 1949, Section 2.

Reich, Charles A.: The Greening of America. Random House, New York, 1970.

Report of Presidents Committee of Urban Housing. Washington, D.C., 1968.

Riis, Jacob August: The Battle with the Slum. The Macmillan Co., New York, 1902.

Rodwin, Lloyd: The Future Metropolis. George Bragiller, New York, 1961.

Wendt, Paul Frances: Housing Policy: The Search for Solutions. University of California Press, 1963.

CHAPTER VII.

CONSIDERATION OF HUMAN NEEDS AND BEHAVIOR

CHAPTER VII. CONSIDERATION OF HUMAN NEEDS AND BEHAVIOR

Introduction

The goal of this report is to lay the foundation of a decisionmaking mechanism for housing. Primary questions relating to this goal are: "What kind of housing? For whom? Where?" At a minimum, the answers to these questions should be consistent with the goal of the Housing Act of 1949: "A decent home and a suitable living environment for every American family."

What does a decent home mean? The answer is not obvious. The answer must relate to the needs or desires of the occupants. Who are these occupants, and what are their wants? People are not homogeneous and we are dealing with every American family. The definition of a decent home cannot be a constant.

If the housing criteria, then, are not constant, how does one proceed? Must the housing need be satisfied on a tailor-made, person-by-person approach? Hopefully not. Hopefully, the social and psychological sciences can provide class criteria by which the needs of groups of people can be defined. The workability of the housing-system model depends on the ability to affect some such grouping of criteria. In this sense, the success of the decisionmaking mechanism rests only on that supposition. If this hope is justified, the three questions of the first paragraph should be approachable.

Suppose that the social and psychological sciences provide data concerning the desires of potential occupants. How does one identify which of a usually conflicting set of needs should be used as decision criteria? The most primary needs would have to be selected. But by whom? Ideally, not by agency or by builder, but rather by the people themselves, working with professionals who can help them to identify and verbalize those basic needs. Nevertheless, we might expect some commonality — some set of wants common to all people, or at least to people in indentifiable socioeconomic classes.

The elements of this chapter are, for the large part, directed toward forming attitudes and approaches toward either the nature of the commonalities or how they might be identified. The included material relates more specifically to the interactions between people and houses and the inter-

actions between people within a built environment (home or housing complex or neighborhood or city). As such, the inputs to the model relate to the housing production (What kind of house? How many? Where?) and market characteristics submodels (Houses for whom? Who will occupy them? And in what way?) and to the concept of the new city and the variable alternative living unit.

Model Demands for Human Needs and Behavior

Overview. In the last section, it was shown that the housing model must proceed from input and/or about the ultimate user. Such considerations enter the submodels in many ways. A partial list of "human" inputs is as follows:

Submodel	"Human" Input
Public services	Social services Social attitudes
Land use	Aspects of land-use planning (community land improvements)
Housing production	Market characteristics Information accessibility Aspects of building codes
Market characteristics	Demographic data Housing occupancy Financial and social incentives Aspects of land-use promotion
Research	Social engineering

To a great extent, these inputs are overlapping. However, in the remainder of this section, the model elements are treated in a brief expansion. In the next section, general concepts regarding interpersonal and person-environment interactions are discussed.

Summary Comments on Model Elements and Interactions

1. Social services (public services submodel) — These are the services which satisfy a socioeconomic need of the population and community

and include education, health, safety, security, welfare, and recreation. In the context of the public services submodel, these services are the vehicles by which social policies are carried out. The instruments are thus the physical facilities, the land, the personnel, the services to the physical plants, and the interactions of all these with the environs.

2. Social attitudes (public services submodel) — These are the general attitudes and beliefs of people with respect to the type and quantity of services which can and should be provided by a community. These attitudes are based on the sociocultural state of the people concerned. The necessity for the model here is to identify the service wants of the people on the basis of their location. This information will then be traded off against tax base, community size and relations to others, legal provisions, and available land and resources.

3. Aspects of land-use planning (land-use submodel), community land improvements — This topic deals with the provision of health, education, welfare, transportation, public safety, utilities, and recreation facilities. Here, we are concerned with the land allotment for these activities. The allotment will depend on such items as the attitudes of the community occupants and their leaders, on the physical needs of the services, on land prices, and on competition for land use.

4. Market characteristics (housing production submodel) — This refers to the user consumptions of housing; i.e., who buys or rents what types of living unit, and where. Market characteristics will act as constraints on the management with regard to how many houses, what type, and where homes should be built; what is currently being bought today and yesterday directs management's outlook as to what will be bought tomorrow. The data for this input are precisely the output of the market characteristics submodel.

5. Information accessibility (housing production submodel) — This item contains the nonmarket, housing-related information input to the management element; i.e., information on technical innovations, aesthetics, and human needs, as reported by the popular or the professional press, by television or radio, or by professional contact will contribute to the decision of management as to what houses will be built. The output of such information sources could then be a significant influence on the operation of the submodel. The input to the information system will come primarily from the research submodel.

6. Aspects of building codes (housing production submodel) — Building codes are a means of protecting the physical needs of humans in their structures. As such, the codes must have input from both technology and from human needs. To date, the human needs input has related entirely to aspects of safety and physiological need, and has been largely in the realm of lore and experience. The National Bureau of Standards, however, has taken a more progressive outlook and has recently added social scientists to the Code Advisory Staff within its Building Research Division. An issue of whether codes should relate to other than physical needs has never really surfaced, but could become a future consideration for code-related policies. Also, in the context of codes, if a meaningful trend toward performance codes is developed, a necessary input would be the precise identification and quantification of the human needs to be met. Implied in the concept of a performance code is a substantial research and development effort aimed at this understanding and quantification.

7. Market Characteristics

a. Introduction. The output of this block is the user consumption of housing; i.e., who buys or rents what type of living unit. "Who," in this case, refers to the geographical distribution of Americans who are presently making decisions regarding a change of abode.

A potential home buyer or rentor froms his decision regarding his housing choice according to many variables. His previous background certainly has a great influence. For example, many Americans raised in the southern states will refuse to buy a house which is not constructed of brick. Another important factor is his current housing status; e.g., a couple with five children would have a strong motivation to move from a two-bedroom house, particularly, if they know that a four-bedroom house is available to them. Probably the most important factor, however, is the family's economic status and the financial advantages or disadvantages associated with a change of residence. These financial advantages, in turn, can be greatly affected by governmental and private programs and policies.

The following sections will analyze in greater detail the market characteristic diagram in Chapter III:

b. Requirements

(1) Demographic data — The implication, here, is that an individual's housing desires and potentials are in part determined by his

previous background and his present status. Thus, a knowledge of the geographical population distribution of people with these characteristics is essential to a model which will produce market characteristics. The demographic data required are enumerated and justified as follows:

(a) Economic status — This factor is self-explanatory. The economic status of an individual is generally the single most important factor which influences his housing decision [VII-1].

(b) Formal education — A high correlation exists between a person's education and his prejudices [VII-2]. This is certainly true also in the matter of housing choice.

(c) Place of birth and previous places of residence — A person's housing preference is influenced by "what he is used to."

(d) Marital and family status — The housing desires of a single person are usually quite different from those of a married person. In addition, the size of the family is an obvious consideration. (Family, here, includes all who may be living in the same residence, including children, mothers-in-law, etc.) The emergence of communes and homosexual associations indicates that such marriages may also have an influence on the housing market. Also, the housing desires of a divorcee with children are different from those of a married couple with children.

(e) Sex (gender, not avocation) — For example, a young, single woman has different preferences from a young, single man.

(f) Ethnicity — For example, people of Italian heritage tend to prefer large kitchens.

(g) Age — A couple in their 70's might prefer a small, easily maintainable home. A couple with young children will probably prefer surburbia.

(h) Religion — A strict Catholic, for example, might prefer that his home be located near a Catholic church and school.

(i) Housing education — This refers to an individual's knowledge of the housing alternatives available to him.

(2) Housing occupancy

(a) Current residence — This could actively be considered as demographic data, but is considered separately for emphasis. Residence can be divided into type and location.

1 Type — Type is an all-inclusive term concerned with all aspects of the house which are independent of its location. This includes economic value, sentimental value, physical condition, size, age, and style. These factors may influence the inhabitant to either move or "stay put."

2 Location — This includes the social status of the neighborhood; the population density; personal relationships with neighbors; safety; pollution and other environmental considerations; nearness to relatives; climate; distance to work, shopping, and schools; cost of living; size of town; and community facilities available.

(b) Housing stock available — This includes all housing stock which is presently available for purchase or rent. All characteristics listed above under current residence must also be enumerated in this category. Obviously, a minimal housing stock will retard movement.

(3) Financial and social incentives — These refer to incentives to an individual to change his place of residence. These could be government or nongovernmentally related. Some examples follow:

(a) Government financial incentives.

1 An individual may qualify for "235 housing."

2 Property taxes may be lower in another area.

(b) Job-related financial incentives — Job promotions in large corporations are often dependent upon willingness to relocate.

(c) Governmental social incentives — These might more accurately be defined as moral incentives. For example, the President might appeal to the middle-class populace to accept subsidized housing in their neighborhoods for the good of the country.

(d) Private social incentives — The zero population growth movement will certainly affect housing needs.

(4) Land use — This refers to the land which is available for potential housing construction. A lack of land will obviously retard new housing construction.

c. Controls (i.e., methods of adjusting the effects of the previously listed requirements).

(1) Government, industrial, and institutional programs and policies.

(a) Military conscription and military housing practices — The effect of these is immediate and fairly obvious. Relocation and division of families has a large effect on housing requirements.

(b) Household or family related legislation — For example, liberal divorce laws might cause more relocations to occur; liberal abortion laws cause smaller families.

(c) Policies on social distributions — Examples of this are the British New-Town Plan and the American Homestead Act.

(d) Income-related policies — The federal income-tax deduction for mortgage interest has certainly influenced the number of home owners.

(e) Enforcement of housing codes — Many individuals could be forced to move if strict housing codes are rigidly enforced.

(f) Housing programs — The effect of urban renewal on housing is one example of the effect of housing programs.

(g) House-related tax policies — For example, local property taxes.

(h) Land-use policies — Land-use bills currently before Congress could affect the amount and type of land available for housing.

(2) Promotion. Promotion refers to governmental and private advertising to alter housing inclinations.

8. Social engineering (research submodel). This input refers to the investigation of human interrelations with other men and with the environment in which he lives. As such, social engineering relates to those elements of sociology, anthropology, physiology, social and environmental psychology, and architecture which have ultimate implications on the structure of homes, neighborhoods, communities, or cities. This element has strong input to the public services, housing production, and market characteristics submodels.

Rationale For Areas of Concentrated Study

In the last section the human inputs to the model were defined more explicitly than in Chapter III. (In Chapter VIII the nature of the specific connecting links within and between submodels is amplified.) In the next section, the bases on which decisions relating to quantifying human inputs are discussed. In few cases, however, the bases are already so well established that clearcut decisions can be made. To point to some areas which must be considered to make rational decisions is attempted.

It is perhaps useful to point to the history within the Human Needs and Behavior Task Group which led to these concentration areas. Within the entire Design Group, much time was devoted to hearing expert testimony and to reading. The choice of an explicit direction of our efforts was postponed until fairly late in the program. Design Group topics ranging from components of houses to the welfare of the world's people were considered at one time or another. It was clear that any topic would need input on human needs and behavior. To point the reading of their task force, an assumption was tacitly made that the final topic would relate strongly to either the dwelling structure or to the formation of new cities. To some extent, then, the next section speaks most directly to these aspects of the housing system.

The areas to be considered were determined on the basis of task force discussions and are to be taken as neither complete nor systematic. We invoke the scarcity of time in the Design Program as largely contributory to these imperfections.

Areas of Concentrated Study

Prefatory Remarks. The following items of this section describe areas of consideration with respect to human needs. In most cases these ask, rather than answer, questions, and they point to the need for further work in many of the areas. In that regard, some explicit recommendations of this type are set forth in the next section.

The problem areas described relate over the whole range of the housing system as it regards people. An attempt was made to arrange the topics in an order from city-related to house-related. Many topics relate to a broad spectrum of institutions and are hard to place in the sequence. In that sense, the sequencing is arbitrary.

Size and Location of Cities. About 40 years ago, 80 percent of United States citizens lived in a rural environment; but, in 1980, 80 percent will live in metropolitan areas. The reasons for this clumping of population are economic. As Adam Smith noted, "The greater the agglomeration, the greater is the division of labor possible; and this permits increased specialization, easier application of technology, and the use of nonhuman energy, economies of scale, external economies, and the minimization of the frictions of space and communications [VII-3]." Hauser [VII-3] indicates that the trend towards increased urban and metropolitan concentration of population is likely to continue. On the other hand, Chermayeff and Alexander [VII-4] indicate that our present, decentralized cities are becoming less and less attractive. In 1902, Ebenezer Howard [VII-5] neatly compared the advantages and disadvantages of city and country life. He pointed out the economic advantages mentioned earlier, but also mentioned the closing out of nature, isolation of crowds, high rents and prices, foul air, murky skies, and slums. Howard's solution was the "garden city" (see Appendix B), which was designed to incorporate the advantages of both town and country. The present surburban trend seems to indicate similar desires. Unfortunately, the suburb seems to primarily incorporate the disadvantages of both. It is too dense to be a countryside, but not dense enough to be a city. Chermayeff and Alexander [VII-4] stated, "The view from the picture window is of the other man's picture window." In addition, the suburb has produced a transportation problem and associated pollution which this country is trying desperately to solve.

Thus, any predictions about future town sizes are muddled, to say the least. With the increasing trend-setting abilities of our young people (i.e., stop the war and save the environment), it may be wise to notice the present movement of some of them to rural areas, both communally and individually. On the other hand, each person is a individual. Many individuals will revolt against trends and try to demonstrate their individuality by living a life style contrary to the majority.

One point to be drawn from the above is that city life, country life, and town-country life all have their own advantages and disadvantages, and each individual weighs them differently as he develops his preferences regarding the location of his home. Thus, if everyone is to be able to find a satisfactory place of abode, there must be a variety of city and town sizes and locations available. In other words, if user preferences are taken into account, there is no single optimal city size. This may seem obvious, yet social scientist for ages have been recommending ideal sizes. Hippodamus and Plato recommend cities of 50 000, while Le Corbusier recommends

cities of 3 million, and there are many other recommendations in between [VII-6]. The English "new towns" vary from 30 000 to 60 000, while the designers of Columbia, Maryland, are planning for a population of 100 000.

Thus, the size of each city should fit the needs and desires of the potential inhabitants. This size is closely related to its location. Thus, the "satellite towns" near London are relatively small because of the availability of special services within that city. The proximity of Baltimore and Washington certainly influenced the designers of the new towns of Columbia, Maryland, and Reston, Virginia. It is certainly pleasing to imagine a pattern of urban centers, with sizes decreasing in proportion to their distance from the center, separated by greenbelts and connected by mass transit. This idea is not new [VII-5]; on the other hand, it has not really been implemented.

Since a variety of city sizes and locations is necessary, the information relating city size to city characteristics is important, both for new town planning and for development of the housing model. The remainder of this section will be devoted to this subject.

Dyckman [VII-7] states that there is relatively general agreement among investigators that some city size between 250 000 and 500 000 offers the complete market basket desired by urbanites at a scale which is most manageable with respect to the frictions of size. However, the rationale and "hard data" which generate these numbers are not mentioned. Ogburn and Duncan [VII-8] present some more detailed results regarding city-size differences which can be expected to persist. Some conclusions which can be reached from their data are as follows:

1. The density of population of an urban region increases with city's age. Thus, both population and age (at the minimum) must be used to correlate social data.

2. The size of the central business district, relative to the total area, increases as the population increases.

3. The size of the market (i.e., the population) will determine the number and types of consumer products, medical specialties, business services, and public services available.

4. Family income increases as population increases. This effect is not obviated when higher costs in the city are considered.

5. The market for luxury goods and the ability to support cultural entities (museums, sympony orchestras, etc.) depend upon a critical mass of the well-to-do. Hence, on the average, these are not found in cities below some critical size.

6. Innovations are fostered more readily as cities increase in population. To some extent, this is a result of greater intolerance of eccentricity in small places.

7. There will be more deviant groups as city size increases.

These conclusions also indicate some interesting relationships between city size, medical specialties available, and business services available.

Hawley [VII-9] shows the following with respect to retail institutions in cities of different sizes:

1. When the average size of institutions, in terms of sales, is calculated for each city size-class, it becomes evident that as cities increase in size their institutions grow larger.

2. There is a pronounced inverse correlation between number and size of institutions in different sized cities.

3. Mean per capita sales increase slightly, but irregularly, with size of city.

4. The variation of per capita sales within a group of similar sized cities is greater than that between size-groups of cities.

5. Mean per capita sales increase markedly for similar-sized cities since they are located farther from the metropolitan core.

6. Old population cities possess a notably larger total institutional volume than do young population cities.

7. Income exerts the most important influence on variation of per capita sales within a size-group.

The above works are only meant to be indicative of the available data relating city size and city characteristics.

Social Considerations Within Cities

The Present Situation. Two of the most salient characteristics of the American population are its diversity and its concentration. An increasing heterogeny of people shares not only the same land area, but also the same life space [VII-3]. This is especially true of the American large city, which carries a large and growing proportion of the total population. Projections indicate that by 1985, 71 percent of the population will live in metropolitan areas as compared to 63 percent in 1960 [VII-3].

Diversity (which may be taken to mean the number of subgroups in a population) tends to increase with size [VII-10], and concentration increases this effect.

However, a contrary effect may be observed. Diversity of groups does not necessarily lead to integration among them; in fact, the effect is quite the opposite. Diversity is accompanied by conflict and segregation. In terms of racial distribution, the cities are becoming increasingly segregated with respect to race. Nonwhites are increasingly concentrated in the central cities, while whites are increasingly suburban. One projection indicates that :

> "By 1985, 75 percent of all nonwhites within metropolitan areas would be resident in central cities and only 25 percent in the surburbs. In contrast, by 1985, 70 percent of the whites would inhabit the suburbs and only 30 percent live in central cities [VII-3].

The black population in the United States is undergoing its own population explosion, mostly within the large urban areas. The concentration of large numbers of economically disadvantaged blacks over a short period of time in racially compacted areas is one of the most serious problems of American society.

One study has shown that the extent of racial residential segregation in the United States is increasing rather than decreasing. Tauber and Tauber [VII-11] were able to show by the use of an index of segregation with census tract data that the extent of neighborhood segregation increased

between 1950 and 1960. They predicted a further increase by 1970, and preliminary results from the 1970 census have shown this to be the case.

The Index of Segregation used in this study is computed in the following manner:

Area	White (%)	Nonwhite (%)	Difference
1	10	20	10
2	20	40	20
3	40	15	25
4	30	25	5
Total	100	100	ΣD 60

$$SI = \frac{\Sigma D}{2} \qquad \frac{60}{2} = 30$$

The measure is computed by taking one-half the absolute difference between the distributions, as the formula indicates. It indicates the minimum percentage of either group who would have to move to another area to achieve a balance. For racial groups, the areas used are census tracts. The measure is a versatile one in that the differentiation between many other kinds of distributions can be ascertained. For example, to measure occupational segregation one merely substitutes occupational categories for white and nonwhite.

In this hypothetical example, the index of 30 indicates that 30 percent of either group would have to move to another area (tract) to achieve a racial balance. The average index for Standard Metropolitan Statistical Census in 1960 was around 85 [VII-11].

Racial segregation is not the only type. A study by Duncan and Duncan [VII-12] utilized the measure given above in showing a strong tendency for occupational groups (professional, clerical, laborers, etc.) to segregate themselves spatially. The main conclusion of the study is that social distance between occupations (i.e., differences in prestige, income, and educational requirements) results in a spatial separation between them. The data utilized in this study are for the city of Chicago and come from the 1950 census. Some doubt exists about how far in time and space the

results can be extended. The study, although widely quoted, has not been replicated. However, informal observation seems to indicate an extensive degree of occupational segration.

Occupational segregation would lead one to expect residential separation based on income, since income is closely related to occupation. Thus, low-income people typically occupy segregated sections of American cities. Low-income housing project and urban renewal programs have often contributed to this tendency by concentrating large numbers of disadvantaged people in small geographical areas. Moreover, public housing, in addition to income segregation, has historically conformed to and continues to reinforce racial segregation [VII-13].

Consequence of Socioeconomic Segregation. There seems to be fairly wide-spread agreement about the consequences of segregation in communities. (The term "segregation" is used to refer to spatial separation on the basis of any characteristic; e.g., race, occupation, or social class.) The reasons for regarding segregation as undesirable derive from a cyclical set of events, the results of which are becoming more and more apparent in our cities. In outline, the cycle proceeds as follows:

1. Communities typically evolve in the direction of neighborhood segregation on the basis of occupation, prestige level, income, or race. This occurence seems to be inherent in the dynamics of city growth.

2. Residential segregation may lead to social isolation, a condition in which the individual has little contact with or knowledge of conditions outside his neighborhood or community and tends to view his community as coextensive with the world.

3. Isolation leads to an essentially one-sided, incomplete view of the composition and workings of the total society. The common picture of the cosmopolitan, urban city dweller is grossly atypical. In the large cities, the central city slum dweller is essentially a resident of a block or a small number of blocks, rather than of the city as a whole. He has little or no knowledge of the city outside his own neighborhood. The same can be said of the suburbanite.

4. Isolation tends to contribute to interclass and race misunderstanding and hostility. This is apparent in the rhetorical exchanges between black militants and whites in the continuing degrading restrictions placed on welfare recipients and in the recurrent notes of Social Darwinism sounded in legislatures across the nation.

5. Class and race hostilities contribute to the perpetuation of segregation and isolation and to the perpetuation of low-income life styles and attitudes. This leads to further expressions of hostility, including violence and rioting, which hasten the physical decay of the central cities and broaden the hostility of the working and middle classes toward the poor and the black.

Avoiding this cycle in existing cities seems almost impossible. The cycle can perhaps be interrupted through small-town designs which throw together people from variety of class and ethnic backgrounds. However, this problem is far from simple. It has been pointed out that:

> Social stratification has led to geographic separation, and this in turn has accentuated social stratification, and perpetuated class division, and it is unrealistic to assume that these class divisions can be overcome merely by reducing the physical distance between classes. It is also highly improbable that the different classes would use the same social institutions. All that would be achieved is the present pattern of social and geographic differentiation on a smaller scale [VII-14].

There are also those who argue that since communities tend to separate "naturally" on the basis of similarity, conflict will result from any attempt at integration. Dr. Joseph Intermaggio related in his talk to the Auburn Design Group (June 17, 1971) that the residents of Reston, Virginia, resent and resist the mixing of different occupational and income levels in their neighborhoods. Studies have shown that homogeneity produces more congeniality [VII-15] and that conflict arises between people of different backgrounds [VII-16]. Perhaps if a balanced neighborhood were created, people would separate themselves within it [VII-14].

On one hand, one readily observes a tendency among people to seek out housing where similar people live [VII-14]. On the other hand, Paul Goodman argues that social groups should be confronted with each other's values and says that we should look forward to a conflictful community to combat the emptiness of technological life [VII-17].

Similarly, in situations of not very high prejudice, the introduction of personal contacts between members of different ethnic groups tends to lead to a lessening of prejudice, and even of discrimination. People not in direct competition with members of minority groups are less likely to be prejudiced toward them. There is somewhat more prejudice and discrimination in hard times than in good ones. Social conflict is more intense the less the contact or openness between disputants and the less integrated the community involved in the conflict [VII-18].

Thus, there are indications that at least contact should be maintained between classes, and that competition between classes should be minimized.

Planners of new towns have generally opted for socially balanced communities usually without specifying exactly what a balance consist of. The new town Tapiolo, Finland, received inhabitants from different walks of life; therefore, it was realized from the beginning that various adjustment difficulties might occur [VII-19]. The new town of Jonathan, Minnesota, will be divided into several villages each of which is conceived as a community of approximately 7000 persons housed in a variety of units covering all price ranges and including most density types [VII-20]. The town of Columbia, Maryland, seems to have been designed with a similar plan in mind.

However, these examples are highly selected. New towns have been designed for a great variety of reasons, many having nothing to do with an optimum socioeconomic mix.

A UNESCO publication [VII-21] reports about 200 new towns built between 1940 and 1960. Purposes for building were the creation of capital cities, strategic or military reasons, relieving central city congestion, and escape from population pressure [VII-6].

Many community developments in the United States deliberately create social class segregation. The town of Clear Lake, Texas, is a good example of this. The community is divided into three geographically separate subdivisions consisting of houses at three price levels. This design deliberately perpetuates the social class segregation and isolation discussed above.

Some Problems in Low-Cost Housing and Neighborhood Integration. With regard to low-income housing, it has been argued that such programs are of limited value since they are only an indirect attack on the basic problem: poverty. Herbert Gans [VII-22] has commented that public housing

came into being as an antipoverty scheme, the idea being that when people had better housing they would be less poor, or at least they would behave less like poor people; but good housing is only good housing - it does not attack the causes of poverty. If people are unemployed, moving them into public housing will not give them jobs or solve their noneconomic problems. Gans, however, goes on to say that he is in favor of low-income housing, and that there is not enough of it. There are many kinds of low-income housing, some little better than the slum conditions it supposedly alleviated, but some consisting of well-integrated neighborhoods [VII-13].

In contemporary public housing, the scattered-site concept and home-ownership schemes such as the HUD 235 Program seem to be coming to the fore. Both of these can be much more realistically viewed as antipoverty schemes than can concentrated, high-rise public housing. There are several reasons for this. For one, ideally, the placing of low-income housing in scattered sites gives the residents conventional middle-class neighbors, which presumably they will attempt to emulate. The danger, of course, is that they will attempt to emulate the consumption patterns of their neighbors, without having the wherewithal to do so.

With respect to the ownership-subsidy programs, it is felt that home ownership is a positive motivating force, that people will be motivated both to maintain their property in an acceptable way, and to strive for economic betterment. This assumption seems reasonable. For one reason, it appears that the conditions under which housing is acquired is one of its most important characteristics [VII-14]. For another reason, the house is the primary symbol of status in the United States. Ownership of a decent home symbolizes a higher class status than public housing rental. This is likely to motivate residents to behave in ways consistent with the higher class status. As mentioned above, one danger is that they will selectively emulate aspects of the life styles of the middle class. Consumption patterns are much easier to learn than are the basic attitudes toward work and property which characterize the middle class.

Perhaps a more basic danger is that the incorporation of the attitudes and values of the better-off toward work and advancement may actually be counter-productive. There is a fairly close balance in society between the number and kind of jobs available and the number and kind of people available to fill them. Merton [VII-23] has shown that the dispartiy between culturally prescribed goals and socially approved means of achieving those goals can lead to deviant behavior or to hostility and withdrawal.

To put it more simply, there is no profit in a man wanting a job or possessions that he has no realistic chance of getting legitimately, because he may turn to illegitimate means or to withdrawal.

Despite these considerations, the scattered-site concept and the 235-236 programs are a significant advance over other types of low-income housing. They seem to be based on a much better understanding of social and psychological dynamics. As has been pointed out [VII-13], the main problem with this type of housing is that there simply is not enough of it, especially for the lowest segment of the low-income population. Low-income housing is no substitute for a concerted antipoverty program, but it is a good supplement to one.

Social Aspects of Land Use. During the past 25 years, the primary location of population increases in this country has been the suburbs. A variety of reasons has been given for this, but the predominant reason seems to be that the suburbs contain the advantages of both city and country life. Howard [VII-5] says that the town-country image is one of social opportunity, beauty of nature, pure air and water, high wages, plenty to do, no smoke, no slums, bright homes and gardens, cooperation, etc. Unfortunately, the suburb also incorporates the disadvantages of both town and country. Chermayeff and Alexander [VII-4] give an excellent description of the problem in their chapter entitled "The Suburban Flop." A few quotations:

> "The suburb fails to be a countryside because it is too dense. It fails to be a city because it is not dense enough, or organized enough. The view from the picture window is of the other man's picture window. Neighbor remains stranger and the real friends are most often quite far away, as are schools, shopping and other facilities. The husband suffers the necessity of long-distance commuting, but the housewife who remains behind suffers the far greater pain of boredom."

Other disadvantages of our suburban spawn are ecological. They encourage two- or three-car families, change grass to concrete, and isolate the city from the countryside. As Lewis Mumford [VII-6] states, "Our growing cities have already lost most of the recreational advantages that the surrounding countryside once afforded them, and one suburb after another has filled in the natural greenbelt that, when the railroad stations

were a few miles apart and commuters lived within walking distance of them, gave it a pleasantly rural flavor."

Once again, it seems that the satellite community approach may be a reasonable alternative.

The question of land use within new towns itself is also of importance. The "best" mix of industry, shops, services, housing, etc., depends upon the size, location, type of transportation, type of industry, etc. Many schemes have been proposed for such in-town layouts. Many seem to take into account important factors such as locations of school, shopping, industrial, and recreational facilities, but many seem to be overplanned. In a new city, it is almost impossible to build character into the plat; planners just have to hope for the best. Carefully segregated use areas are inclined to be dull because of their sterile regularity and homogeniety; the strict separation of land uses and, therefore, of types of people in the area so beloved of modern planners if monotonous and boring. Cities benefit from having history written into their buildings and neighborhoods; otherwise, they are antiseptic and lifeless. Compare walking through a typical surburban tract with traversing the central city: one tract house after another quickly bores the viewer; on the other hand, walking through the downtown or an ethnic district of a metropolis offers captivating variety. It is this seductive quality of excitement and drama that makes big cities such irresistible lures [VII-6].

Land use is discussed more fully in Appendix B on New Towns.

<u>Privacy Versus Community.</u> "Only through the restored opportunity for first-hand experience that privacy gives can health and sanity be brought back to the world of the mass culture [VII-4]." It is generally recognized that privacy is a basic human need. Ideally, each individual and family (or larger group) should hava a safe retreat from intrusion upon any of the five senses.

On the other hand, man is a social being. That man is a political animal is evident in the spontaneous growth of social bodies in the new towns [VII-24]. In addition to this basic social drive, there are practical advantages to neighboring, such as mutual safety, convenience, etc. This has led some town planners to overorganize the community spirit of the townsfolk. In England, the planners regarded community centres and neighborhood units as means of integrating the diverse activities

of individuals and families into an organic social whole of progressively larger dimensions — the community, town, region, and national. They rationalize this goal in terms of an organic sociology or social philosophy in which individuals and groups in a society are likened to the parts of a mechanical system or the organs of an organism whose specialization contributes to the harmonious functioning of the whole. This kind of planner mentality is more than useless; it is insidious and harmful. One can only plan and organize things, institutions and inanimate objects; one cannot plan human beings. If people do not want to be neighborly, then it does not matter how many Community Association Halls there are, the results will still be the same [VII-25].

Gregarious hallo-ing takes place up and down the streets, but there is little house-to-house visiting or home entertaining. This seems surprising when it is considered that most new-town people had not had a home of their own before, and now take pride in their houses and gardens. The basic desire seems to be to create a good pleasant home for the family, and this factor exists independently of the equally important desire to create a constructive, integrated community [VII-26].

The same holds true for the individual family. Provision for voluntary communality rather than inescapable togetherness is essential [VII-4].

It is generally accepted that both privacy and neighboring can be greatly influenced by architectural styles. Reference VII-27 lists privacy and social intercourse among the five aspects of way of life which affect built form. (The other three are basic needs, family, and position of women.) He comments that social intercourse is an important factor in the layout of a city, a neighborhood, or even a home. Settlements can have communal space or effectively waste space between houses (observed in anthropological studies), depending on the culture. The types of interaction are also important. For instance, a Moslem town requires a quiet family realm, a larger group (clan) domain, a coffee house (for men's social intercourse), a well (for women's social intercourse), a mosque, and a bazaar (social and commercial intercourse). Analogous elements should be identified and allowed for in contemporary American planning or design.

Alexander [VII-28] has studied the relationships of living style, privacy, and community in great detail; e.g., each house must be within 100 yards' walk of 27 other houses.

It is clear that the opportunities for both privacy and neighboring must and can be made available. However, their use must never be enforced.

Adaptability to Change. It has become a truism that we are living in a period of rapid and accelerating social change. Hauser [VII-3] has coined the phrase "the social morphological revolution," which refers to changes in the size, density, and heterogenity of population and to the impact of these changes on man and society. One important aspect of change is what Ogburn [VII-29] called "cultural lag." This refers to the fact that the parts of society change at differential rates. Ogburn argued that technological change typically proceeds at a faster pace than change in cultural norms and values and in behavior patterns. This differential often produces conflict, confusion, and disorder; elements of culture tend to persist beyond the specific conditions which gave rise to them. Thus, as Hauser [VII-3] points out, such slogans as "that government is best which governs least," which made sense in 1790, still persist and have influence.

With reference to housing, there seem to be more than a few elements of cultural lag present. The structure of the housing industry is anachronistic as compared to say, the automobile industry. Builders adhere to technologically obsolescent materials and techniques. Housing design initates the successes of the past rather than creating forms for the future. In a throwaway society, houses are built for performance. In a mosaic of subcultures the range of housing choice is not wide.

From another perspective, however, the concept of cultural lag may seem overly judgemental. Should housing, for example, slavishly follow the trend toward transience? Could it not perhaps serve as a zone of stability for the family in the midst of change as a kind of buffer against future shock [VII-30]?

There are conflicting arguments about the permanence of housing. Toffler [VII-30] quotes E.F. Carter of the Stanford Research Institute as saying that "the average age of dwellings has steadily declined from being virtually infinite in the days of caves to approximately a 100 years for houses in the United States colonial days, to about 40 years at present." However, Kurtz [VII-31] has estimated on the basis of calculation for the last 2 decades and the 1970's that units will be used on the average for 100 years.

Without trying to determine which of these estimates is most accurate, it is evident that at least some segments of the construction industry are building with fairly fast destruction in mind. There are examples of apartment buildings torn down after only 10 years because improved air-conditioning systems hurt their rentability [VII-30]. Perhaps it would be more economical to build modular separability into air-conditioning and other housing subsystems. But, as the general rate of change in society accelerates, the costs of permanence becomes uneconomical. Buildings must be built for the short-run, since uncertainty about future needs increases as the rate of change.

Perhaps a way out of this dilemma is the "variable alternatives living unit," which would consist of interchangeable housing subsystems. The basic unit could stand for 100 years, while some, or all, of the subunits (e.g., plumbing, heating, and interior walls) could be changed according to need or desire. The implementation of such a concept would refine both dimensional and functional interchangeability. In dimensional flexibility, connections are dimensionally uniform and panel sizes come in some multiples of some standard dimension. In this way, the artifacts themselves could change over the years but still be amenable to incorporation in all homes.

These kinds of interchangeability could be accomplished by industrialized housing systems based on the concept of "open systems," in which each manufacturer's products would be compatible with all others. Thus, manufacturers would be able to specialize in one or a few products which would be compatible with a wide range of complementary products. (For further consideration of these matters, see appendices.)

Mobility and Stability. The phrases often heard indicate that Americans are becoming more mobile. Charts are shown that indicate how far the average move is, and what the reason for moving is. These charts and statements seem to give the impression that each family moves once in 5 years and, therefore, are becoming more mobile. Perhaps there should be an analysis of this moving population to determine whether everyone is moving, or whether there is just a segment that moves very often while the rest of the population remains stable. This might well mean a new set of housing provisions and considerations.

Social Engineering. The present Director of Research of the American Institute of Architects describes buildings as settings for human activities.

In this context, one may consider social engineering in the explicit context of designing the home and its immediate environment so as to enhance the social well-being of the occupant. It is in this area of sociological provision (or control) that one has some reasonable chance of success. Architects perceive their triune role as artist, technologists, and social designer (not necessarily in that order). While there is some recent self-examination which causes the architect to question the effectiveness or magnitude of his role as social designer [VII-32], there is little doubt that he can indeed play an influential sociological role. That the architect should be effective is seen in the following three ways: (1) his design of patterns and dimensions of flow can clearly enhance or diminish social contact among inhabitants; (2) it appears that, throughout the world, the form of the housing unit is directed in major part by the monopoly of social traditions of the inhabitants [VII-27] — It may fairly be expected that some reciprocity exists in this relationship; and (3) Somer has documented an overwhelming variety of cases in which environment has played a significant role as a social determinant [VII-33].

However, it appears that the architect has operated almost entirely by intuition in designing for social accommodation. Put in other terms, he has manipulated space with little predictibility as to the outcome [VII-34]. The partnership of an architect and a social scientist on design projects has been of sufficient novelty to be reported in an architectural glossy [VII-35]. It appears that much effort is necessary before the social design aspects can be placed on a firm predictive footing. Most probably, the only method of attack will be by direct observation of people in their home surroundings — The kind of study Sommer has used so effectively [VII-33]. In this area, there is apparently a fair backup of cut-and-try methods and rules-of-thumb which will do until a firm basis is established. Nevertheless, a research program designed to study sociological-architectural relationships would be very much in order.

Aesthetics. Aesthetics and its affects on the home dweller may be one of the least understood elements in the housing problem. Some of the recent projects which begin to seriously consider this area include NASA's Skylab and Tectite projects. Thus far, much of the psychological work directed toward the affect of the environment on people has dealt with foreign environments, giving very little data which can be applied to the housing problem. The perception of beauty and the environment is influenced by age, cultural background, education, travel experience, geographical location, social status, economic status, exposure to technology, and exposure to marketing influences. These are but a few of the factors. They are the

same factors that make each person unique. "Beauty is in the eyes of the beholder." Research into the area of aesthetics and its psychological affects on the home dweller has just begun. Much more research will be required before one can understand it well enough to really design for it on any large scale. Designs should provide several options and make the dweller aware of them. Too often the designer designs for himself and tries to force the home dweller to accept his preconceived standards.

Choice. A primary aim of a housing policy must be to make available a choice of housing type, location, and financing for all people in all income categories. A lack of choice appears to be present in some measure throughout our culture; consider the ubiquity of the two-story colonial house and the two-story linear apartment house. The problem of choice is most severe in the lower-income sector, because of their lack of leverage with the building dollar. Builders appear to respond to the inclinations of those who will purchase the house. The lower-income occupant is a second-order user, however, and only with difficulty has his preferences expressed in the built living unit. Several consultants of our group have pointed out that one source of problems in public housing and in other lower-income projects is the feeling of the people that they have no freedom to either go somewhere else or contribute to their living space design.

"More Than Shelter," a source document of the Douglas Commission [VII-13], has pointed out that:

> "Public housing has been an attempt to do things for selected poor families. Management is unilateral. Tenants have no sense of involvement. Tenant apathy and hostility are inevitable under such circumstances."
>
> "The interest of low income families are rarely, if ever, represented on the boards of local housing authorities. The concerns, desires, needs, and aspirations of the low-income consumer are rarely considered in the planning, development, and operation of housing for low-income families."

Clearly, it is important to involve the ultimate users, always, and in a substantial way, in the decisionmaking processes leading to low-cost housing. It is one of the suggestions of that report that:

"The shelter needs for a large proportion of the low-income population can probably be best served through a system of subsidies to the families rather than by subsidizing houses."

This procedure would provide the economic leverage needed to reach the builder. This may identify two possible paths (not necessarily mutually exclusive): user input in project development planning or direct people subsidies.

Within the dwelling unit, a further desire for variety and flexibility exists; variety in terms of multiplicity of settings and spaces, flexibility in terms of multipurpose, multiuse, and convertible spaces. Tradeoffs here with economic aspects should have a primary input to design, and people would like to make their own tradeoffs between quality and cost.

Types of Ownership and Occupancy. The conditions under which housing is acquired is at least as important as the housing itself. Housing in which people have no personal stake is often ill-treated. However, the need for ownership is related to position in the life cycle and to occupational status. Young couples and single people typically rent apartments; older families with children desire single-family houses and buy them if they can. Couples whose children are grown often move into apartments or smaller houses.

The FHA 235 Program provides home ownership for low- or moderate-income people who could not otherwise share in this most central American operation. The motivation seems to be to stimulate those so benefitted to join the great American middle class. Although, ironically, the subsidy decreases as the family's income increases, which would not seem to be the optimum method of producing incentive, it seems more like a punishment for advancement.

FHA 235 housing is often tied to the "scattered site" plan which is often strenously resisted by residents of existing neighborhoods in which such housing is placed [VII-36]. However, once such housing is in place, anticipated problems often fail to materialize [VII-13].

The 236 Program provides for cooperative ownership of five or more units of detached, semidetached, row, or multifamily housing [VII-36]. In

this form of ownership, the family is a member of the cooperative corporation which owns the housing. Equity is accumulated in the co-op as the principal is reduced. The family may sell his share in the corporation at anytime. Family payments against the mortgage are subsidized.

This form of ownership has unique advantages for low- and moderate-income families. The cooperative offers the family a transition from rental occupancy to full individual ownership. While achieving and accepting control over the private areas, the family is provided certain communal benefits (e.g., maintenance of communal property, market controls on resale, and direct influence on the future of the housing). Also, the family is allowed to adjust to the idea of home ownership without taking the big step [VII-36].

A similar form of ownership can be found in Tapiola, Finland, where the apartment owners in a multistory building are stockholders in a joint stock housing company that is managed by a board that is appointed by the occupants at the annual company meetings [VII-19]. The interesting aspect of this form of ownership is that it involves a share in the total community, and presumably may lead to interest in the affairs of the whole community rather than the individual's isolated part of it. This form of ownership seems particularly interesting for this reason, but probably would not be readily accepted in this country because of difficulties in financing and associations with communism.

Unique tenancy problems exist among the lowest income group in the United States: welfare recipients and those below the poverty level. These people obviously cannot compete for standard housing. Yet only about 7 percent of those classified as poor in the mid-60's lived in public housing, only 25 percent received public assistance. Those receiving public assistance but not living in public housing are in effect subsidizing substandard housing [VII-13].

Poor families are far more likely than others to be problem families: to lack male heads and to have members with behavior and personality problems. These families are also less capable of dealing with these problems. They are often considered undesirable tenants, and there is in part some evidence that where public housing policy has shifted in the direction of admitting all eligible families regardless of social criteria, the social environment has steadily declined to the level of the slums [VII-13].

If public housing is to be open housing, avoidance of physical and social deterioration will require that special techniques, management practices, and flexibility be developed to cope with resulting problems.

Among the problems which must be dealth with are: (1) children are often left at home, unsupervised; (2) the style of life is often highly permissive; (3) parents control over teen-age children is minimal; (4) children have few acceptable success models; (5) group pressures forbid conformity to middle-class standards; and (6) poor people are conditioned to expect and do expect to be exploited [VII-13]. Thus, although some of those who have a poverty lifestyle can be expected to become upwardly mobile and adopt more conventional lifestyles and to attempt to earn their way without subsidy, there is an unspecified but large proportion who will remain nonmobile and in need.

To stimulate mobility, one of the requirements is a social environment which provides models and standards to aspire to. This has to be coupled with the realization that often it will not work, and it requires that unstable, problem-ridden families be given the opportunity to live in an otherwise stable social environment; i.e., among people who do not share the same problems to anything like the same degree. This requirement runs head-on into the aspirations, the values, and the self-interests of the nonpoor. One cannot be optimistic about implementing this beyond a very nominal limit [VII-13]. Yet, if something like this is not done, public housing, to a greater extent than before, may become a repository for the unwanted.

Leisure Time and Recreation. Man is known by the leisure he keeps. For adults, concepts of leisure time range from being the reward of life's work to a necessary psychological and physiological escape from the rigors of the world to a set of voids to be somehow filled in the course of the day's activities. For children, the lines between leisure time and other periods is less clearly delineated and can occupy a large portion of the day. Central to the idea of leisure is the concept of self-determination — the refreshing right to decide what to do with one's self. In the planning of any human setting, their right must be respected. In this context, it is implied that significant spaces must provide a broad set of alternatives, places in which individuals can exercise self-determination and self-realization.

The character and breadth of activities and activity spaces provided must vary with population characteristics and densities and with the physical nature of the surroundings. Clearly, not many small communities can support

a symphony orchestra or a professional football team. Likewise, hunting and golf are incompatible with central city spaces. But even with limited resources, much can be done. For instance, Japanese architecture and landscape architecture have been studied for ages because of the sensitive simplicity with which they blend a broad variety of activities within a limited landscape.

One potential pitfall in recreation planning is to fill the available spaces with facilities which are too explicit. If artifacts or spaces too strongly suggest what must be done (swim in the swimming pool, enjoy the flowers along the paths, play tennis on the tennis courts, etc.), leisure time can lose the battle to less productive but less specified activities, such as TV or arguing. Undesigned spaces and undesigned time that encourage man to be what he wants to be are essential.

Institutions that have a special interest in leisure time services are the educational, recreational, service, civic, and religious organizations. Avenues for a productive filling of leisure hours are provided by these groups. Facilities provided for such institutions can, in some measure, become important features of the leisure landscape.

One final point needs to be made. In the low economic class, work is often irregular. Unusual hours and time spent on more than one part-time job are often implied. A result is that leisure time patterns are irregular and the development of an ongoing and productive activity is made very difficult.

Acceptance. The question of what type of house is acceptable to a potential house owner is a very nebulous one. One reason for this is that it is largely an emotional issue. Unemotional alternatives can easily be swayed by logic, while emotional issues defy all logic. Housing acceptability falls into the last category. It brings with it everything from a mother image and security to a class and status symbol. For example, David Pellish (Director of Building and Technology of the New York State Urban Development Corp.) mentioned that many Negros will not accept white tile in their bathrooms because of its association with public restrooms. He also mentioned that many low-income families prefer an English Tudor house with a mansard roof because of the association with middle-class America. Similarly, Jim Simpson (consultant to HUD) said that low-income people are reluctant to accept bare brick interior walls if they feel they are provided only to reduce cost.

Another factor worth mentioning is the importance of house location with respect to acceptance. Armiger [VII-1] illustrates this with the results of

a survey on housing preference of 40 families who have recently moved or are in the process of moving.

Without exception, our consultants voiced the opinion that a new housing structure which does not resemble a traditional house is unlikely to be salable. This task force has not been able to find sufficient evidence to either support or negate this opinion. (This seems to be an area needing further research.) However, it is evident that this attitude stifles innovation and leads to a circular pattern, with people not being able to change their ideas of acceptance because of the lack of variety available.

"Hard" Needs of a Home. Recalling our objective of a decent home and a suitable living environment, a question is immediately raised: What are the needs of the inhabitants? The needs of an inhabitant can be placed in two categories: hard and soft. Physiological maintenance, safety, access and egress within the house and to external areas (yard, shopping, work, etc.), and economics are included among hard needs. The soft needs may be grouped under "sociological" and "psychological," separating, in this way, intra- and interpersonal relationships with the home environment.

The hard needs relating to the house itself (as distinct from the house in a socioeconomic environment) can be described by a list of physical requirements which a house should meet. Clearly, external access consideration as well as economic needs are excluded from this list, and the elements of the list can be traded off against access, economic, or soft consideration. The tradeoff could be in terms of degree or of absence. One attempt at a list is given below:

Functions of a House (Hard)

1. Provide places for sleeping.

2. Provide shelter from weather.

   a. Wind.

   b. Precipitation.

   c. Heat.

   d. Cold.

e. Direct sun.

f. Humidity.

g. Atmospheric pollution.

3. Protection from the criminal element.

4. Storage provision.

   a. Cloth goods.

   b. Large and small hardware.

5. Disposal of personal effluent.

   a. Excrements.

   b. CO_2.

   c. Body heat.

6. Provide personal hygiene facilities.

7. Provide for cooking usage.

8. Provide area for relaxation and/or personal development.

9. Provide place to eat.

10. Provide comfortable atmosphere.

    a. Temperature.

    b. Humidity.

11. Allow for sexual activity.

12. Provide isolated space (reading, thinking, etc.).

13. Insulation from noise.

    a. Outside — inside.

    b. Inside — outside.

    c. Between rooms.

14. Protection from pests.

15. Provide lighting for all activities.

16. Provide space and surfaces for writing and working.

    Generally infers a level floor.

17. Provide space for family interaction.

18. Provide ability to use various small appliances.

19. Communication (visual) with immediate exterior.

20. Communication with remote exterior (telephone, radio, and TV).

21. Safety (from potential hazards within and without the home).

22. Maintain adequate pressure and mixture of atmosphere.

23. Allow for decoration.

24. Allow for good access to outside.

25. Provide for convenient, sheltered parking.

Guidelines for meeting these requirements are not collected in any one place. However, a search of the architectural literature and the aerospace literature (astronauts' living spaces are very functionally designed) appear to yield a good deal of the design information. The reader is referred specifically to Reference VII-37.

Safety. Two aspects of home acceptibility are safety relative to hazards within the home and safety from hazards outside the home. The former relates to the design, construction, and equipage of a home. The latter relates to these and also to the site for the home. A number of the consultants to this group emphasized aspects of intra-home safety (Pellish, Foster, Radnofsky, Lowry, Wilson). As an overview of this area, the following general conclusions can be reached:

1. A great deal of ad hoc safety "lore" exists pertaining to specific aspects of housing construction.

2. Much of this "lore" is incorporated into building and housing codes and into construction technique.

3. Some research is in progress to establish optimal solutions to specific hazardous situations (especially fire).

4. Little study is underway to establish relative priorities of importance in safety design.

Rational design, however, must depend on considerable progress in areas 3 and 4.

Work on priority structuring and specification for codes is underway, under NASA contract, at Brown Engineering Corporation. Their effort proceeds through the following stages:

1. Establish the relative frequency and severity of home accidents.

2. Identify the causal factors contributing to fixture-related home accidents.

3. Relate the causal factors to current building codes and standards through engineering and human factors analyses.

4. Develop revised or new building code specifications in those areas which are deficient or in which there is insufficient information.

The first two stages were carried out by occupant mail questionnaires.

It is tempting to show the results of their survey. However, the concensus of our task force is that the population sample and the polling techniques were both flawed. It would be incorrect to assign importance to these accident frequency data. The concept of the study was, however, an apparently correct one and one which should be undertaken again with more care. This type of information (the relatively frequency of source of accident and the relative frequency of causes for each accident source) is indispensible and should precede the allocation of time and money for the solution of specific safety hazard problems.

The task group has not searched vigorously for other sources of safety hazard data; quite likely, other sources do exist. Care, again, should be taken to examine the sample from which the data were taken and the biases which might be implied.

Psychological Interactions With the Home. The question of psychological needs is a very difficult one. To some extent, the psychological needs and the sociological needs overlap. But we add here questions as to the extent with which such things as color variation and intensity, heat, humidity, etc., will affect the behavior patterns (as opposed to physiological breakdown) of a person exposed to them. Also, what will be the nature of the effects? These questions are crucial to the human-functional design of the house. But, there appear to be few useful answers. Certainly, there are no quantitative answers yet.

Nevertheless, over the last several years, a discipline termed "environmental psychology" has been emerging. This field deals directly with questions of real-world environment-behavior relationships. According to the "rules of the game," the environmental psychologist will usually act only as a transducer, as opposed to an operator [VII-38] ; i. e., he will not control the games played, but will act as an observer and interpreter of natural events. More-or-less, early results in this science have shown that the relationships are complex. First of all, the individual appears to respond to the totality of his setting, indeed, the totality as it is integrated over some period of time. However, while differences in behavior as acted on by different settings are easily observed, the interpretation is often very difficult [VII-38]. Secondly, the differences in prior mental programming of individuals causes a very wide variety of behaviors to be motivated by the same environment [VII-39, VII-40]. The most recent review of this area indicates that little of useful substance has yet been produced [VII-41]. The parameters of the problem areas are still undergoing rapid re-definition.

The other source of data comes from the older laboratory psychology literature. In this area, environmental factors are singled out in the laboratory for their one-dimensional effect on human or animal subjects. This material fills the psychological periodicals. However, most environmental psychologists warn that this material is seldom immediately extrapolable to the complex situations encountered in real environmental design.

It is possible that a unified theory of environment-behavior interaction may emerge on the basis of a general theory of complexity drive [VII-42]. On this model, there is an optimum psychological complexity state; i.e., an optimum state of activation of brain cell units with regard to number and pattern. This state is responsive to prior history and to the environment. The individual will act so as to return to the optimal state when he has been drawn away from it. Variety has been shown to be a very primary drive in cases of sensory deprivation [VII-43]. Further, complexity correlates very well with pleasingness and interestingness [VII-44]. These studies on complexity seem to be qualitatively observed in responses to photographic slides of the visual environment [VII-41]. There are two implications of all this: (1) that we may have an overall basis for hypothesis on environmental effects, and (2) that at least a modicum of complexity should be incorporated into design.

Conclusion

Further Study and Research. Further research in any given area generally leads to a better understanding of that area and, ultimately, greater progress in that area. In this sense, further research is needed in all of the social and psychological aspects of housing. However, several specific areas have impressed the Human Needs Task Group as being in particular need of further research. These will be mentioned below along with some suggestions for methods of conducting this research.

New towns are being constructed, and efforts are being made to include sensible socioeconomic mixes of townspeople in the new towns. Similarly, it is known that some socioeconomic mixes seem to retard upward mobility of citizens of established towns. Further research is needed to attempt to determine the advantages and disadvantages of various class mixtures of people.

The question of complexity need is one that also needs further study. The idea that man needs some complexity in his immediate environment seems

to be in direct conflict with the modern architectural concepts of clean lines and practical design.

Many technological innovations also have sociological and psychological implications which may not be immediately evident. For example, it is clear that American plumbing systems are very inefficient and wasteful of water (e.g., the Swiss have a nonvented plumbing system, while Europeans, in general, use less water to flush their toilets). Similarily, electrical wiring could be improved significantly, especially with regard to insulation durability, safety within the electrical boxes, and speed of installation in rehabitated houses. (Flat conducting cable might be used to alleviate the latter problems.) It would be unfortunate if such innovations were thwarted because research had not verified public acceptance of such items.

There are many ways of conducting the research indicated above. For example, physical innovations could be tested in Indian housing, Department of Defense installations, and mobile homes, where codes are not restrictive. Both physical and sociopsychological innovations could be studied in certain proposed new towns; e.g., the Minnesota Experimental City [VII-45] or Disney World [VII-46]. A more definite approach would be the construction of a human factors housing laboratory. In this laboratory, families would be exposed over extended times (say, months and perhaps by permanent settlement) to a maximally variable housing environment. Information would be taken regarding transient and final behavior with regard to the placement of subsystems. Further, the house and its subsystems would ideally be expandable and contractable in terms of both size and quantity, and the occupant would trade off real or monopoly money for changes or for housing vis-a-vis other activity things. Such a human factors laboratory would tax technology to its utmost in providing the needed flexibility and would provide valuable information regarding housing needs and inclinations.

Summary

Human needs and behavior have been identified as providing primary requirements and constraints for the housing system model and for the decision-making mechanism. It was pointed out that needs differ throughout the population, but that the needs may be amenable to correlation by socioeconomic classes and by location. It was also asserted that design must be based on

people's desires, but that the interpretation of these wants may require the use of professional social scientists.

Points of impact of human factors on the housing model were identified and described. In particular, the input to the market characteristics submodel is particularly significant.

A number of areas of more detailed work was examined. These areas are related to factors which must be considered as the elements of the housing model are made quantitative. In general, problems are posed in these considerations and few guidelines were obvious.

Finally, several areas of research were recommended. For the most part, the recommendations are related to sociological and psychological studies and model situations.

REFERENCES

VII- 1. Armiger, L. E., Jr.: Towards a Model of the Residential Location Decision Process. A Study of Recent and Prospective Buyers of New and Used Homes, Master's Thesis, University of North Carolina (Chapel Hill), 1966.

VII- 2. Schmid, C. F., MacConnell, E. H., and Van Arsdol, M. D., Jr.: The Ecology of the American City. Further Comparison and Validation of Generalization, G. A. Theodorson, ed., Studies in Human Ecology, Harper and Row, Evanston, 1961.

VII- 3. Hauser, P. M.: The Chaotic Society: Product of the Social Morphological Revolution. American Sociological Review, vol. 34, no. 1, February 1969.

VII- 4. Chermayeff, S., and Alexander, C.: Community and Privacy. Doubleday, New York, 1965.

VII- 5. Howard, Ebenezer: Garden Cities of Tomorrow. MIT Press, Cambridge, 1902, 1965.

VII- 6. Thomlinson, Ralph: Urban Structure. Random House, New York, 1969.

VII- 7. Dyckman, J. W.: City Planning and the Treasury of Science. W. R. Ewald, Jr., ed., Environment for Man: the Next Fifty Years, Indiana University Press, Bloomington, 1967.

VII- 8. Ogburn, W. F., and Duncan, O. D.: City Site as a Sociological Variable. E. W. Burgess and D. L. Bogue eds., Contributions to Urban Sociology, University of Chicago Press, Chicago, 1964.

VII- 9. Hawley, A. H.: An Ecological Study of Urban Service Institutions. George A. Theodorson, ed., Studies in Human Ecology, Harper and Row, Evanston, 1961.

VII-10. Mott, Paul E.: The Organization of Society. Prentice-Hall, Englewood Cliffs, 1965.

VII-11. Tauber, Carl E., and Tancber, Almo: Negroes in Cities. Aldine, Chicago, 1965.

VII-12. Duncan, O.D., and Duncan, Beverly: Residential Distribution and Occupational Stratification. American Journal of Sociology, vol. 60, 1955, p. 493.

VII-13. George Schermer Associates: More Than Shelter. The National Commission on Urban Problems, Government Printing Office, Washington, D.C., 1968.

VII-14. Schorr, Alvin L.: Slums and Social Insecurity. U.S. Department of Health, Education, and Welfare, Social Security Administration, Division of Research and Statistics, Washington, D.C., Research Report No. 1, Government Printing Office, Washington, D.C., 1966.

VII-15. Festinger, Leon, Schachter, Stanley, and Back, Kurt: Social Pressures in Informal Groups. Harper, New York, 1950.

VII-16. Form, William H.: Stratification in Low and Middle Income Housing Areas. Journal of Social Issues, vol. 7, nos. 1 and 2, 1951, p. 109.

VII-17. Goodman, Paul: Utopian Thinking. Commentary, vol. 32, no. 1, July 1961, p. 19.

VII-18. Berelson, Bernard, and Steiner, Gary A.: Human Behavior: An Inventory of Findings. Harcourt, Brace, and World, New York, 1964.

VII-19. Hertzen, Heikki V.: Practical Problems of New Town Development. New Towns Seminar, Working Session III, Tappiolo, Finland, August 13, 1965.

VII-20. Jonathan New Town: Design and Development. Jonathan Development Corporation, Chaska, Minnesota, 1971.

VII-21. Viet, Jean: New Towns. UNESCO Reports and Papers in the Social Sciences, no. 12, UNESCO, Paris, 1960.

VII-22. Gans, Herbert, and Glasgow, Robert W.: The Ayn Rand Syndrome. A Conversation with Herbert Gans with Robert W. Glasgow, March 1970.

VII-23. Merton, Robert: Social Structure and Anomie. American Sociological Review, vol. 3, 1938.

VII-24. Kuenstler, Peter: Community Organization in Great Britian. Association Press, New York, 1961.

VII-25. Gibson, Geoffrey: New Town Ghettoes. Socialist Commentary. April 1955.

VII-26. Gibson, Geoffrey: Impressions of Two New Towns. Universities and Left Review, Autumn, 1958.

VII-27. Rapoport, A.: House Form and Culture. Prentice-Hall, Englewood Cliffs, 1969.

VII-28. Alexander, D.: The City as a Mechanism for Sustaining Human Contact. W. R. Ewald, Jr., ed., Environment for Man, The Next Fifty Years, Indiana University Press, Bloomington, 1967.

VII-29. Ogburn, William F.: Social Change. Viking Press, New York, 1922.

VII-30. Toffler, Alvin: Future Shock. Random House, New York, 1970.

VII-31. Kurtz, John: Making of Living Places. Thesis, Carnegie-Mellon University, 1970.

VII-32. Lipman, Alan: The Architectural Belief System and Social Behavior. British Journal of Sociology, vol. 20, 1969, p. 190.

VII-33. Sommer, Robert: Personal Space. Prentice-Hall, Englewood Cliffs, 1969.

VII-34. Conway, Don: Personal Communication, 1971.

VII-35. The Physical Dimension of Architectural Space. Progressive Architecture, 1965, p. 159.

VII-36. Scattered Site Equity Housing, Candill, Rowlett, and Scott, Architects, Hartford, Connecticut.

VII-37. Kennedy, Robert Woods: The House and the Art of its Design. Architectural/Environmental Handbook for Extraterrestrial Design, NASA Document MCR-70-446, Martin-Marietta Corp., Reinhold, 1953, December 1970.

VII-38. Barker, Roger G.: Explorations in Ecological Psychology. American Psychologist, vol. 20, no. 1, 1964, p. 2.

VII-39. Barker, Roger G.: Wanted: an Eco-Behavioral Science. Edwin P. Williams and Harold L. Ransch, eds., Naturalistic Viewpoints in Psychological Research, Holt, Rinehart, and Winston, New York, 1969.

VII-40. Pearson, Richard G., and Hart, Franklin D.: Studies Relating to the Individual Characteristics of People with their Response to Noise. NASA Report N69-11575.

VII-41. Wohlwill, Joachim F.: The Emerging Discipline of Environmental Psychology. American Psychologist, vol. 25, no. 4, 1970, p. 303.

VII-42. Walker, Edward L.: Psychological Complexity as a Basis for a Theory of Motivation and Choice. David Levine ed., Nebraska Symposium on Motivation, University of Nebraska Press, Lincoln, 1964.

VII-43. Schultz, Duane P: Evidence Suggesting a Sensory Variation in Humans. Journal of General Psychology, vol. 77, 1967, p. 87.

VII-44. Berlyne, D. E., Ogilvie, J. C., and Parham, L. C. C.: The Dimensionality of Visual Complexity, Interestedness, and Pleasingness. Canadian Journal of Psychology, vol. 22. 1968, p. 376.

VII-45. Experimental City Project, The Minnesota Experimental City. Progress Report, 3rd Edition, University of Minnesota/Experimental City Project, 1969.

VII-46. McCleary, Elliott: Will 10 000 000 People Ruin All This. National Wildlife, vol. 9, no. 4, June-July 1971, p. 5.

CHAPTER VIII.

DEVELOPING A MODEL OF THE HOUSING INDUSTRY

CHAPTER VIII. DEVELOPING A MODEL OF THE HOUSING INDUSTRY

Introduction

Definition of a Model. A model is an abstraction of a system which can be used to predict the operation or condition of the system through time. The useful aspect of a model is the prediction of conditions of a complex system at future times. A qualitative model gives the general, nonquantitative relationships which are thought to exist between the elements making up the system. A quantitative model states in terms of deterministic and probabilistic equations and numerical values the relationships between the elements. It is necessary to develop the qualitative model before it is possible to go to the quantitative phase. Both types of models are useful, depending upon the accuracy of the prediction required.

Qualitative Models. Qualitative models are used for the explanation of general behavior even though it is impossible to obtain numerical results. Thus, social scientists have developed qualitative models for the description of the behavior of individuals and societies. Although no equations or numerical values are placed on the elements (the societies, individuals, or their interactions) of the model, such qualitative models can be used to predict behavior on a broad scale. A secondary use would be the explanation of past behavior. However, one is usually interested in past behavior only if similar circumstances can be expected to occur in the future; thus, the usefulness of explaining past behavior lies in its use for predictions of future behavior.

Quantitative Models. Quantitative models, relating the elements of a system with equations and numerical values, have been developed mainly by the engineer and physical scientist. The requirement for this type of model lies in the necessity for predicting the quantitative behavior of a system. The problems which are encountered in social systems strongly support the need for quantitative models of social systems. Social systems are very complex; thus, the ability of any individual to predict even qualitative effects of changes in the system or future behavior is not possible. Quantitative predictions without models are impossible. What would appear to be solutions to some social problems have been shown by the use of models to be counterproductive; i.e., the proposed solution intensifies rather than cures the problem. Alternatively, the effectiveness of the solution is much less than had been expected. For these reasons then, it is necessary that realistic and effective models be

developed for social systems. If this is not done, coordinated and effective planning will be impossible and the resultant costs to society will be high.

Modeling Difficulties. Difficulties in modeling a social system can be divided into several areas which are in effect the processes which must be gone through to create a workable model. The first step in the development of a model is the identification of the important elements which make up the system to be modeled. For the housing system, this initial identification of elements was done in Chapter III. The qualitative description of the relationships which exist between these elements will be done for some elements in this chapter. The identification and qualitative description of the elements and their interactions can be a formidable task for social systems such as the housing industry where the elements and their intra-actions may not be easily defined. Because of limitations in time and personnel, it has not been possible to fully develop the qualitative relationships for all the elements presented in Chapter III. However, since readers may not be familiar with this process, an attempt has been made to indicate the steps in the development of the qualitative intra-actions for several of the elements of Chapter III. This is followed with the development of the qualitative interations among the initial elements of the model identified in Chapter III.

Developing A Qualitative Model of the Housing Industry

Suggested Steps. The development of a qualitative model is an iterative process. The following description is of the first iteration in this process and consists of the following steps:

1. Identify the inputs and the outputs for each initial element of the model.

2. Identify the intra-actions, which are the various ways that the inputs inter-relate and combine to produce the outputs.

3. Identify the interactions among the elements. These interactions are the relationships that exist among the initial elements of the model.

4. Evaluate the condition of the model and consider the possibility of adding more elements.

The initial elements of the model for housing industry identified in Chapter III are as follows:

1. Capital.

2. Public services.

3. Land use.

4. Natural resources.

5. Housing production.

6. Market characteristics.

7. Research.

Inputs, Outputs, and Intra-actions. To illustrate a technique for identifying inputs, outputs, and intra-actions, the land-use element of the model will be used in the following discussion.

The output of the land-use process was identified in Chapter III as the amount of land to be used for various purposes. These uses include residential, industrial, governmental, and commercial.

The inputs will be taken as the requirements and constraints identified in Chapter III. Thus, for the land-use process, these will be:

1. Land market.

2. Capital availability.

3. Community land improvements.

4. Site improvements.

5. Land-use regulations.

6. Locational opportunity.

7. Land-use planning.

8. Property tax policy.

These factors have been discussed in depth in Chapters IV through VII and the reader is referred to those chapters for a more detailed explanation of these inputs.

The next step is to identify the intra-actions; i.e., the ways that these particular inputs inter-relate and combine to produce the output that was previously identified. The first-round identification of the intra-actions in the land-use process could be taken as the following:

1. Individual purchases land to build a house.

2. Speculative builder buys land for the building of housing units.

3. Developer buys land then subdivides and improves.

4. Public housing authority buys land for public housing.

5. Professional consortium buys land for new community development.

Table VIII-1 shows the inputs, outputs, and intra-actions as identified for the land-use process on the first cycle of developing a qualitative model of the housing industry.

Tables VIII-2 through VIII-5 are the results of similar efforts to identify the inputs, outputs, and intra-actions for the public service, natural resources, housing production, and market characteristics processes.

Now, an attempt is made to further specify and qualify the intra-actions already identified in the previous step. There are many ways of accomplishing this task. One might document the process in more detail. An example of this approach follows as applied to the intra-actions in the housing production process:

1. The rate of housing production is originally estimated by the collective managements of the housing construction organizations, ranging

TABLE VIII-1. LAND-USE PROCESS

Inputs	Intra-actions	Outputs
Land market	Individual purchases land to build a house	Developed residential land
Capital availability	Speculative builder buys land for the building of housing units	Undeveloped residential land
Community land improvements	Developer buys land, subdivides, and improves	Developed industrial land
Site improvements	Public housing authority buys land for public housing	Undeveloped industrial land
Land-use regulations	Professional consortium buys land for new community development	Developed governmental land
Locational opportunity		Undeveloped governmental land
Land-use planning		Undeveloped commercial land
Property tax policy		Undeveloped commercial land

TABLE VIII-2. PUBLIC SERVICE PROCESS

Input	Intra-actions	Output
Utilities	Distribution system	Allocation of necessary services to residential areas
Types available	Assessment method	
Cost	Taxation Monthly Private	
Social services		
Recreation	Accessability	
Transportation	Metropolitan action consolidation	
Communication	Socioeconomic mix	
Tax base	Community political mechanism	
Community size and relation to others	Mayor and city council City manager	
Social attitudes		
Legal provisions		

TABLE VIII-3. NATURAL RESOURCES PROCESS

Input	Intra-actions	Output
Raw materials	Governmental regulations	Resources that are or will be available for industry (housing or otherwise) while maintaining a desirable ecological balance
Imports	Industry self-regulation	
Research & Exploration	New methods for extracting materials	
Inventory	Recycling or reclamation	
Industry	Development of alternate materials	
Ecological Considerations		
Depletion Rates		
Standards & specifications		
Competing uses		
Technology		
Demand influence on price		

TABLE VIII-4. HOUSING PRODUCTION PROCESS

Inputs	Intra-actions	Outputs
Capital	1. Managements estimate production (within overall capacity) from market characteristics and external information.	Production of houses
Labor		Use of material
Building materials	a. Fiscal policy limits construction money.	Use of labor
Technology	b. Housing stock information used to plan rehabilitation.	Expenditure of capital
Housing stock		Active management
Management	2. Managements manipulate labor, materials, and subsystems to support production within quality limits specified by building codes.	Use of subsystems
Subsystems		Land use
Fiscal policy	a. Production rate slowed if any factor insufficient.	Use of public services
Construction capital	b. Technology applied to maximize efficiency in construction within limits specified by labor practices and policies.	
Labor supply		
Labor policies	3. Public services connected.	
Building codes	4. Construction capital replaced by long-term capital supplied by first direct user.	
Market characteristics		
Public services		
Information		

TABLE VIII-5. MARKET CHARACTERISTICS PROCESS

Input	Intra-actions	Output
Demographic Data 1. Total population 2. Age 3. Sex 4. Family status 5. Marital status 6. Household status 7. Ethnicity 8. Education 9. Economic status 10. Religion Current Residence 1. Type 2. Location 3. Density 4. Public safety 5. Cost 6. Ownership Housing Stock 1. Type 2. Location 3. Density 4. Public safety 5. Cost 6. Ownership Financial and Moral Incentives 1. Job locations 2. Tax incentives 3. Public concern a. Re-overpopulation b. Environment Knowledge of Alternatives 1. Information media 2. Demonstration projects 3. Social intercourse	Potential occupant measures perceived benefits of a change of residence against available housing stock. The incentives to move relate to how well the current residence is perceived to suit occupant needs. Both the perception of benefits of relocation and the nature of the available housing stock can be affected by external controls.	User consumption of housing; i.e., who buys or rents what kind of living unit

from stick builders to semi-industrialized mass producers. It will not exceed their total capacity to produce.

a. Their estimate is derived from their collective evaluation of the housing market characteristics and of externally derived information which may project trends not yet reflected in the market place.

b. The original estimate may be modified by fiscal policy. Its primary effect will be felt through the availability of a construction model to support the operations during the construction phase (before the use of long-range capital by the user at purchase time).

2. Each construction management organization arranges the labor supply, materials, and subsystem for its projected construction. When the total supply of each of these factors cannot support the demand, deliveries are slowed and/or cancelled, projects lie idle awaiting scarce craft labor, and installations are postponed. The net effect is to reduce the overall housing production rate. Utilization of labor is constrained not only on the basis of total hours but must consider availability by craft and special practices and policies which may limit hours/man and/or productivity. For on-site construction, modern technology may be investigated in a search for improved or more efficient materials and/or subsystems. Management must assure that all procedures, materials, and subsystems are consistent with the regulations applied by local building codes.

3. Public services to operate the mass transport, communications, environmental, and waste disposal systems are required. Management assures that connection is made to the public or private utilities supplying these services.

4. The first direct user provides long-term capital when he accepts the house. This replaces the higher cost construction capital which supports the project to this point.

5. The basic output is the number of living units by type produced in a specified time period. This output is a measure of the effectiveness of the collective managements. Secondary outputs are the expenditures of materials, labor by craft, and subsystems required to support this production. Land use for new housing and public service load can also be obtained.

After specifying the intra-actions in more detail, one can then construct a schematic block diagram to illustrate their relationships. It should be noted that this particular approach will assist in the quantification of the model, if desired, at a later stage in its development. The following example of this procedure for the land-use process is taken in part from Reference VIII-1.

Assume that a combination of builders motivated by profit sets out to acquire at the outskirts of a city a sizable acreage of open land for development into a large-scale housing project including a regional shopping center. In one behavioral sequence, they determine an income-producing need for this activity, define their objectives, consider the alternatives, and reach a decision to go ahead and acquire a site. The developers considered three sites. The consequent purchase of a site involves a second sequence of behavior. They determine the extent of their profit needs, set their goals, consider alternatives, and again reach a decision. In this process, they consider a variety of sites. With respect to Site No. 1, the developers' interpretation of public interest values indicates a possible stalemate that they can ill afford. First, they foresee difficulties in obtaining changes in zoning to permit the kind of development they have in mind, and, second, they anticipate that prevailing public policies on extensions of sewer and water facilities will interfere with their plans.

In the case of Site No. 2, the public interest considerations are less important than the culture-bound values. Several members of the combine of developers are respected residents of the small-estate community surrounding Site No. 2, and have been accepted into the colony only after prolonged social maneuvering. Not only can strong opposition from this area be expected, but these resident partners of the enterprise face social ostracism if they permit their profit-making values to prevail. Because of social symbols held by the developers, this highly promising site is eliminated from consideration. Thus, in this behavior cycle, purely profit-making values do not lead to pure consequences, but rather the subsequent decision on Site No. 3 represents a modified decision in consideration of other values.

With the public announcement of intent to build on Site No. 3, a whole new pattern of behavior occurs. One group of nearby residents, motivated by livability values, suddenly becomes organized and, in a series of behavioral sequences, takes steps to thwart the new development. One element of the group opposes changes in zoning that would permit the development of a large shopping facility in the area, maintaining that the great traffic loads converging

on the area would involve hazards to their children and noise and fumes to the general detriment of the area, that the flashing neon signs at night would have a disturbing effect, that the shopping center would deface the natural attractiveness of the area, and that all these considerations would have a cumulated effect of generally depressing property values for residential purposes in the entire surrounding area. Another element of the group, motivated by socially rooted values, opposes the proposed lower-order residential zoning on grounds of social disruptions. In effect, they maintain that the influx of lower-income groups alien to their symbols of social status will threaten the security of the group presently residing in surrounding areas. Both elements of the group were organized initially as separate groups, but in the subsequent behavioral sequence, finding they had similar goals, they merged in the action phase of their missions.

Other groups may align themselves with the developer according to other values: the social need for more housing, the industry-attracting significance of an adequate supply of housing, the properity symbolism of outward signs of growth, etc. As the behavior cycles more from value stimulus to action, these groups may also merge and function as one. Other new cycles may be introduced. For example, the consolidated opposition may seek support of political groups, or the developers and their sympathizers may seek support of influential persons in the community, bringing the community power structure into the controversy.

Obviously, a whole new complex of values quite different from the original profit-making values has been introduced affecting the final outcome of this struggle. The whole scheme may be abandoned, a modified scheme may be adopted as a compromise, or the original proposal may be carried out. What happens and how it affects the configuration of land uses is a consequence of a variety of value systems; thus, the land-use pattern evolves. Sometimes, parts of the scheme are based on actions stemming from a pure system of values unmodified by other systems, and, sometimes, as the foregoing illustration suggests, these actions derive from interacting values, not purely profit making, nor purely public interest or culture-oriented values, but a combination of several values.

A schematic block diagram representing the previously described process and other possible processes within the land-use process itself is shown in Figure VIII-1. It can be seen that Figure VIII-1 is incomplete, but it does represent the skeleton on which can be erected many of the inter-relationships among decisionmakers, their motivations and values and those of the society in which they operate.

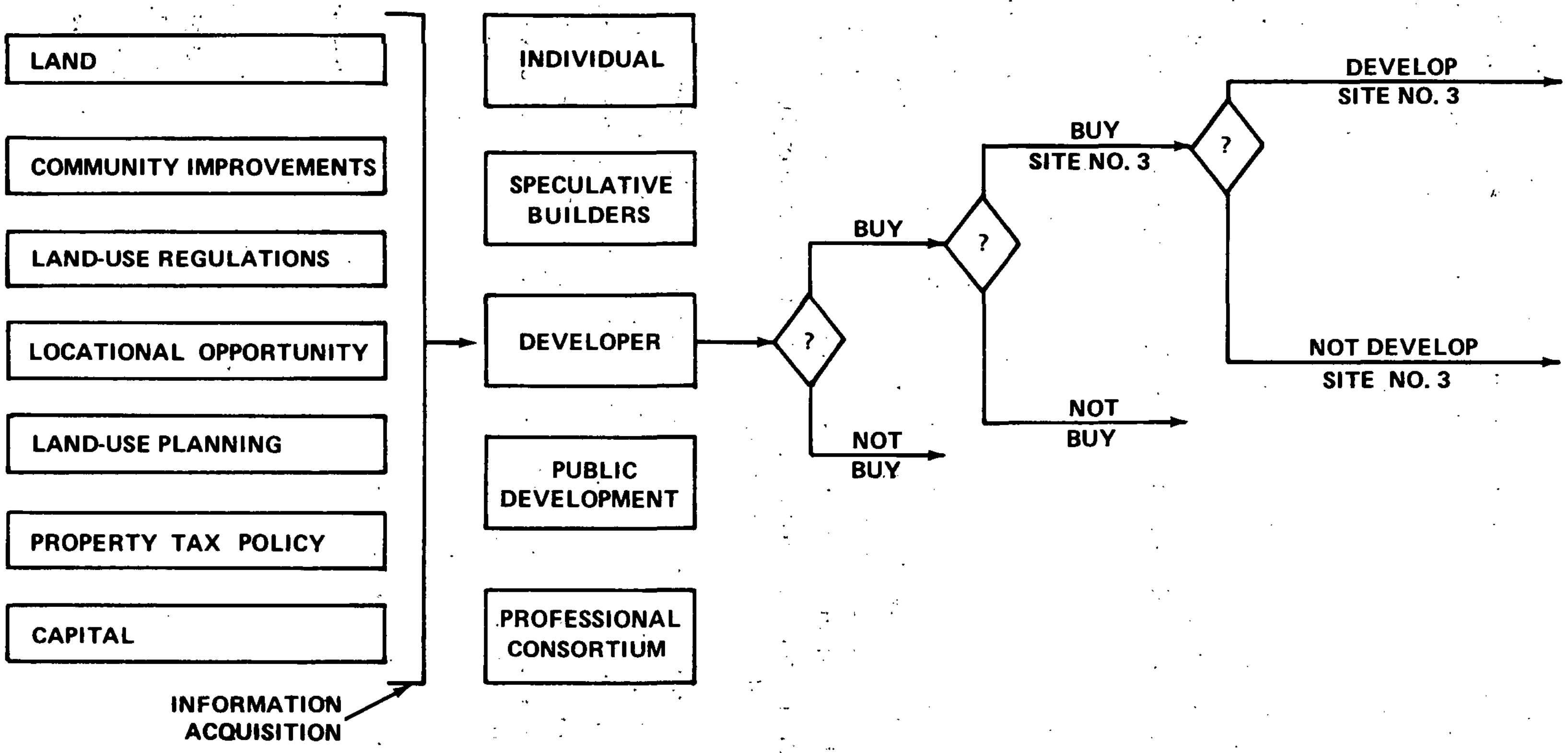


Figure VIII-1. Land-use intra-actions.

The following description is yet another way of identifying the intra-actions for a process; in this case, the market characteristics process of the housing industry. It should be considered the "first cut" in this interative procedure. This first cut was built using a structure which could eventually incorporate quantitative data on a population distribution basis so that it could become part of a complete computerized housing model. The rationale for the model shown in Figure VIII-2 is on the following page.

An individual is constantly forming opinions in his own mind with regard to what he believes his housing status should be. The block representing this operation is labeled "current prejudice." The inputs to the block represent the data which represent the individual's background, and the assumption is made that this historical data can be used, on a probabilistic basis, to determine the individual's housing prejudices. Although any background information is valuable in determining probable housing prejudices, education, occupation, economic status, and ethnic status seem to be the dominant factors (Schmid et al [VIII-2] and Van Arsdol et al [VIII-3]).

An individual also has actual housing needs, which are determined by his present status. Thus, personal data concerning age, sex, family status, and current residence all feed into the block entitled "actual needs." Any reasonable definition will suffice. It is the impact of actual needs upon the "perceived needs block" which is important; in other words, the distinction between current prejudice and actual needs is artificial in a functional sense. An additional influence upon actual needs is rigid enforcement of housing codes or other legal actions which tend to force an individual from his present home.

An individual's current prejudices and actual needs are mixed somehow with financial and social incentives and promotion to form some perceived housing needs or desires. (Incentives and promotion are discussed in Chapter VII in the Market Characteristics Section.) Perceived housing needs simply refer to a person's own judgment regarding his desired place of residence. In addition, an individual's knowledge of available alternatives, affects, to some degree, his desires. However, at this stage, his knowledge is likely to be quite superficial and erroneous.

At this stage, a threshold point may be reached, and the individual may decide to look for another place to live. This step is included primarily as a result of research performed by Armiger [VIII-4] and Rossi [VIII-5]. This threshold point is indicated by the block labeled "formation of intentions to move."

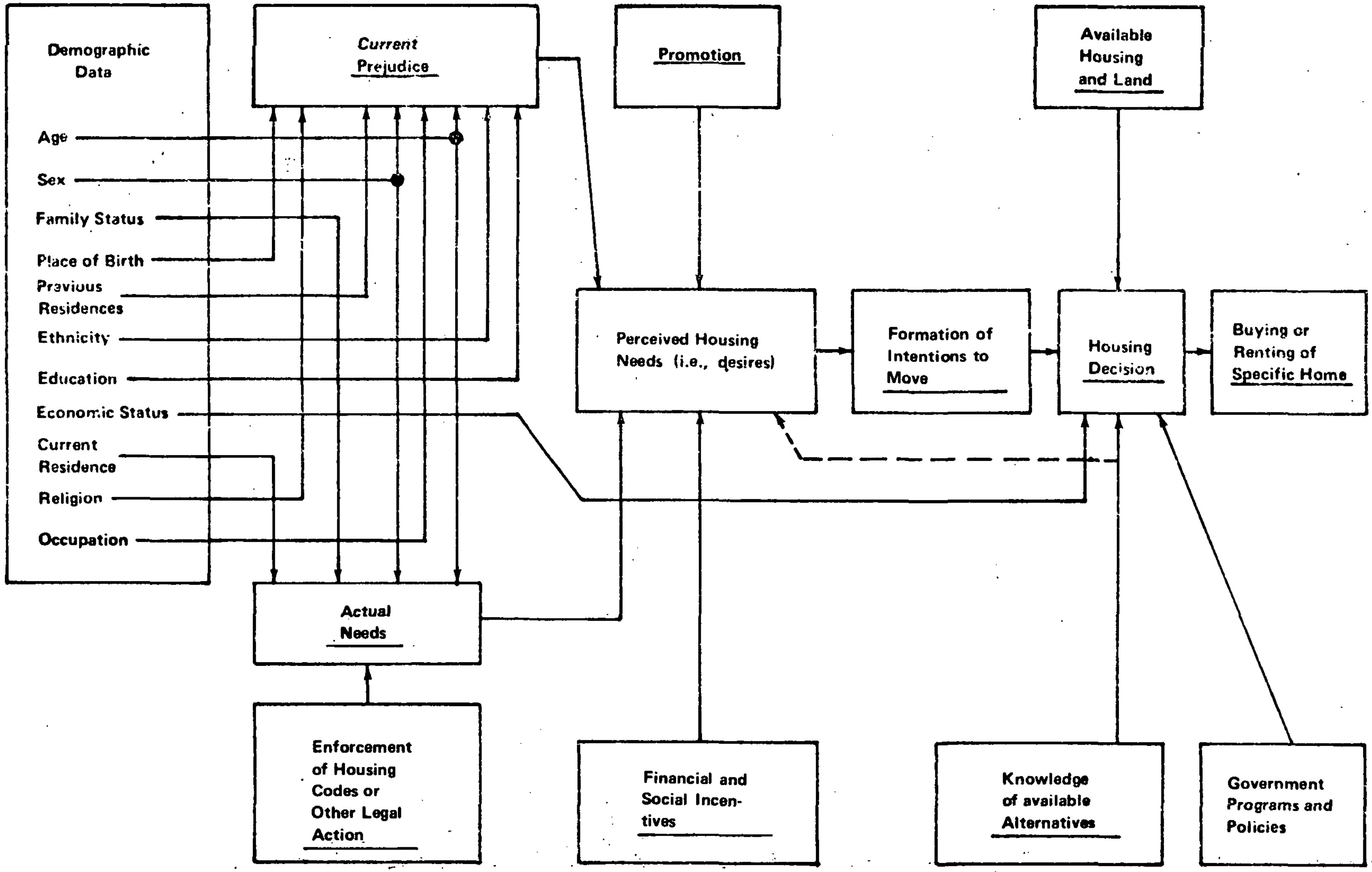


Figure VIII-2. Market characteristics intra-actions.

The individual then begins to seriously study the available alternatives, including the available housing and land and government programs and policies. His present financial status also has a huge impact upon the housing decision.

Finally, the individual buys or rents a specific home.

Interactions Among Elements. The next step in the development of a qualitative model is to identify the interactions among the elements. This can be accomplished by constructing a diagram using the seven initial elements with their respective inputs and outputs identified. Then, one simply connects inputs and outputs that are identical. The result of doing this for the seven elements in the housing industry are shown in Figure VIII-3.

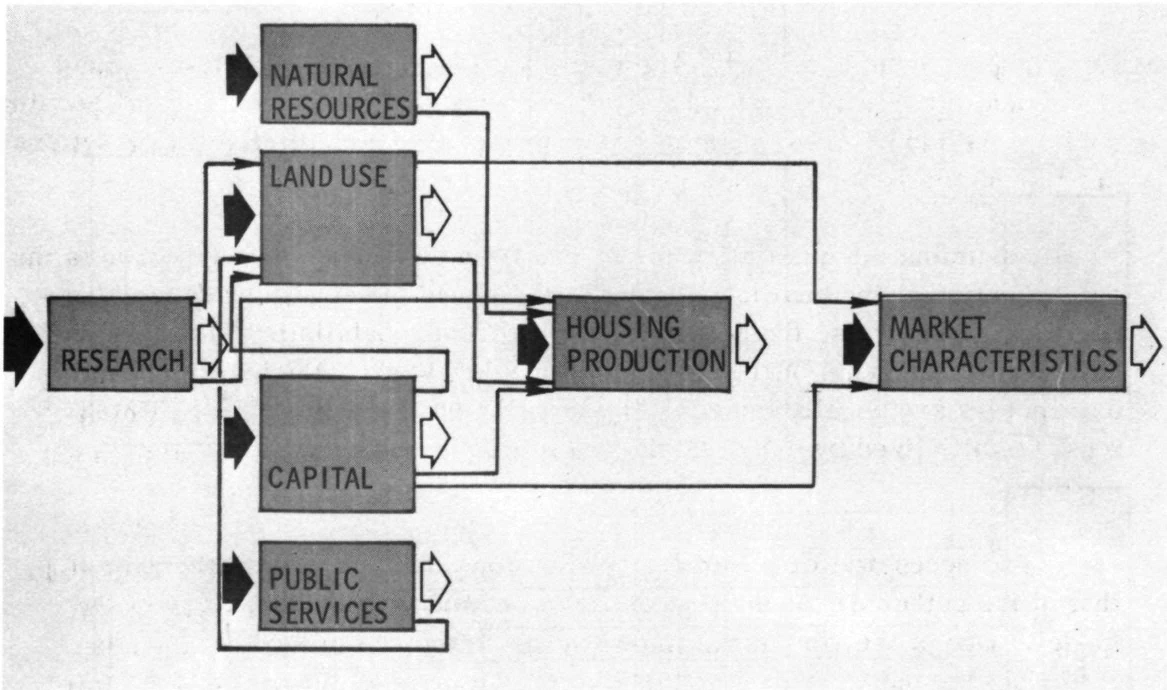


Figure VIII-3. Housing model interactions.

It will be noted that this procedure results in some unconnected input and/or outputs. Here one must evaluate the resulting model and decide: (1) if he can supply the data for the unconnected inputs and (2) if the unconnected output is information he is seeking. If the answer is yes to both of these questions, then a qualitative model has been developed. If the answers to either

of the preceding questions is no, then one should consider the possibility of adding more elements to the model and cycle back through the qualitative model development procedure again. As an example of elements that might be added to the model of the housing industry at this stage refer to Figure VIII-4.

It should be noted that the development of a qualitative model is an iterative process requiring much judgment and a good understanding of the processes involved.

Developing A Quantitative Model

of the Housing Industry

The preceding sections of this chapter have outlined the development of the qualitative intra-actions and interactions for the elements of the housing model. As can be seen, the development of even the qualitative intra-actions and interactions is a very time consuming and complex task.

Assuming the qualitative model has been developed, the next step is the quantification of the qualitative relationships. In the equations describing the numerical terms, the deterministic and/or probabilistic relationships between the elements of the model must be developed. During this phase, parameters are usually included in the mathematical relationships which must be initialized by using the data available from the social system being modeled.

The necessity for parameter evaluation leads directly to the next step, that of the gathering the data necessary to evaluate the parameters of the model. One of the very large impediments to the use of several models formulated to date has been the lack of sufficient data concerning the state of the system in the past. Consequently, the evaluation of some parameters in these models has been educated guess work.

The fourth step, which is closely related to the third, is a check of the model using known data. For example, if we had created a model which was supposed to predict population growth in the U.S., we could, for example, use census data for 1900 and 1910 in an attempt to predict the population in 1920 and 1930. Since we have data available for each of these years, this

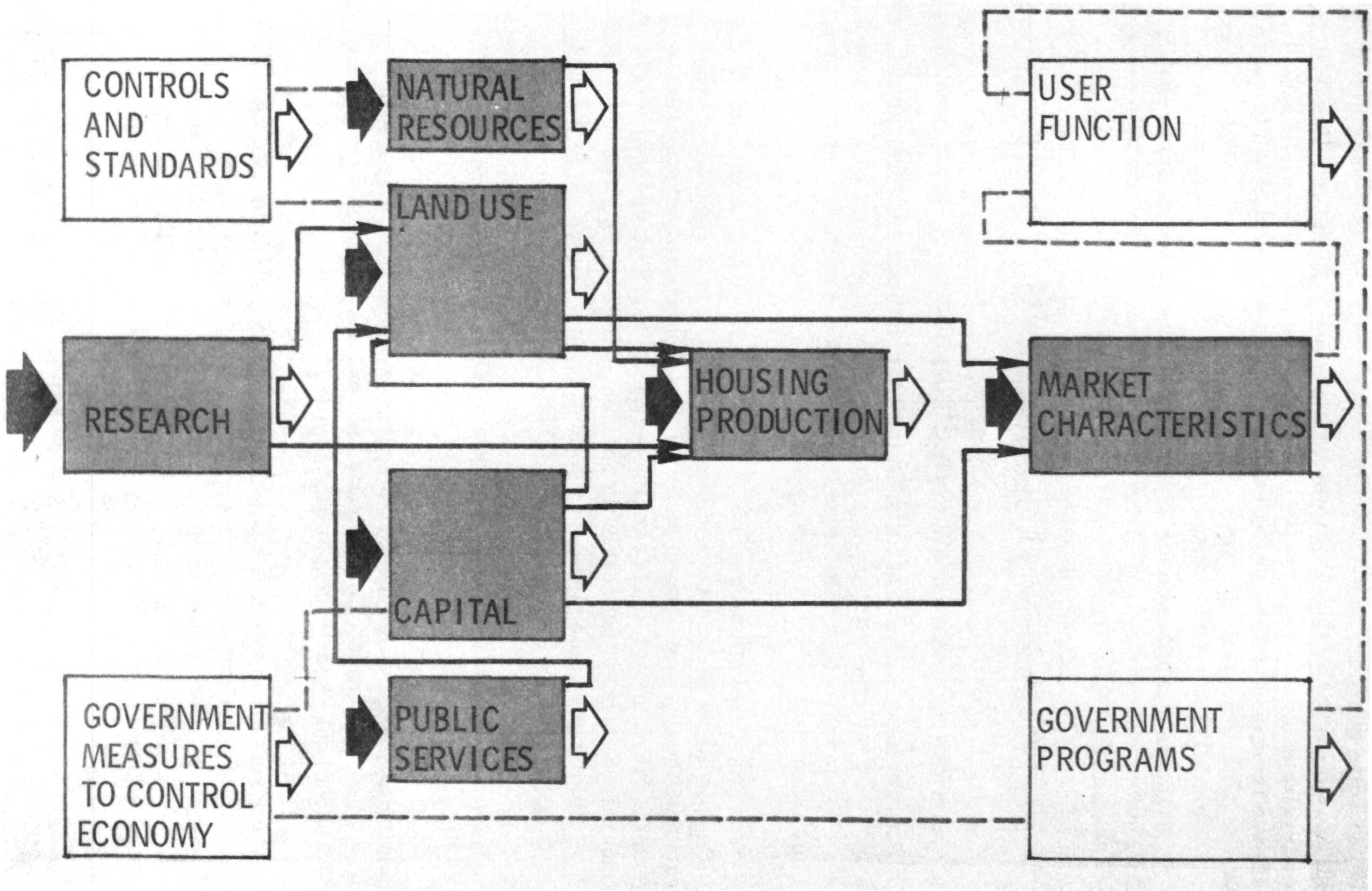


Figure VIII-4. Housing model with possible additional elements.

procedure would serve as a working test of the model. Such a procedure is analogous to experimental data necessary for the validation of physical models in engineering and science. This last step is a very difficult one in the social areas since necessary data are very often lacking, incomplete, or unreliable.

The steps of model development from the quantitative phase forward have not been attempted by this study group. A discussion of several models which have been completed appears in Appendix C, and the reader may wish to study these and other models.

In this chapter, an attempt has been made to outline the work which must be done to complete the model which has been proposed. The qualitative form of this model is relatively complex, and considerable simplification may be necessary to quantify these interactions. It is felt that an appreciation of the difficulties involved in modeling a system as complex as the housing system can be gained from this partial development.

REFERENCES

VIII-1. Chapin, F. A.: Urban Land Use Planning. University of Illinois Press, 1965.

VIII-2. Schmid, C. F., MacConnell, E.H., and Van Arsdol, M.D., Jr.: The Ecology of the American City: Further Comparison and Validation of Generalizations. Studies in Human Ecology, G. A. Theodorson, ed., Harper & Row, New York, 1961.

VIII-3. Van Arsdol, M. D., Jr., Camilleri, S. F., and Schmid, C. F.: The Generality of Urban Social Area Indexes. Studies in Human Ecology, G. A. Theodorson, ed., Harper & Row, New York, 1961.

VIII-4. Armiger, L. E., Jr.: Toward a Model of the Residential Loration Decision Process: A Study of Recent and Prospective Buyers of New and Used Homes. Master's Thesis, University of North Carolina at Chapel Hill, 1966.

VIII-5. Rossi, P. H.: Why Families Move. Glencoe, The Free Press, 1955.

CHAPTER IX.

POTENTIAL FOR IMPLEMENTATION

CHAPTER IX. POTENTIAL FOR IMPLEMENTATION

Introduction

The planning and evaluation model of the housing system is intended to be a useful tool for those who have, or could have, a responsibility in housing outcomes by way of offering the opportunity to:

1. Provide a scientific method that will allow evaluation of the effectiveness of existing public programs and, where appropriate, to recommend alternative programs.

2. Permit the determination and anticipation of opportunities for program formulation.

3. Encourage timely evaluation and corrective action by continuous monitoring of changes in the housing system, as well as policy changes.

4. Allow simulation of conceptual programs involving private and public actions and expenditures.

5. Provide a management technique to monitor the implementation of plans and generate progress reports of a continuing dynamic process that is responsive to unanticipated as well as projected changes in the system.

Potential Users

The decisionmaking mechanism which has been proposed is, in a sense, new techniques for the housing industry. Thus, within the context of the free enterprise system, the same requirements we ascribe to the implementation of new technology apply as follows:

1. Its use must be made attractive to each of the potential users. It must be seen as being in support of his own particular objectives within his own problem environment; e.g., his scheme of things (such schemes will undoubtedly vary for each potential user; thus, the decision mechanism must be flexible).

2. Alternately, each potential user must see a failure to consult the decisionmaking mechanism as potentially putting him in an inferior position with respect to his present or potential competitor.

It should be emphasized that the user is not the operator; e.g., the management of the decisionmaking mechanism. That function must be performed by an organization clearly possessing complete impartiality to all users. Otherwise, its use, understanding, and usefulness will simply come to resemble the fractionated character of the existing housing industry.

In our view, such a housing decisionmaking mechanism should service the needs of the following classes of potential users:

1. Legislative bodies of all levels, such as Congress, state legislatures, and city councils which must weigh the implications of all alternative courses of action relating to the formulation of housing policy and programs.

2. Executive departments and agencies of all levels such as HUD, DOT, DOD, etc. on a federal level, state administrations, and municipal governments and agencies which must propose, evaluate, and implement housing programs and policies.

3. Consumer and other nonprofit groups who wish to evaluate alternates and publish their findings prior to legislative actions or to critically review executive policies.

4. Participant industries of all types and scales such as builders, subcontractors, real-estate developers, manufactors of materials, subsystems, building systems, professional planners, and architects who wish to determine the nature and timing of decisions relating to buying, developing, building, expanding, branching into related fields, contraction of operations, identifying new markets, opportunities, sites and sizes of projects, scheduling and timeline planning, sales projection, hiring practices, and purchase of new plant and equipment.

5. Labor unions which negotiate new contracts determine labor practices and establish training programs.

6. Financial institutions which must develop fiscal policies and financial practices and determine the effects of the economic cycle as related to housing.

7. Nonhousing participants industry which wants to determine the nature and timing of decisions related to possible involvement in housing — whether or not to jump in, how, how heavily, and at what potentially most advantageous, yet least risky, point. What is the nature of the market? Buy an existing firm or develop own? How much existing experience and expertise is applicable to new industry? What is unique about this new industry (e.g., marketing) that is unlike our own? (most failures in housing by nonshelter types in the past founded on the rock of ignorance in these latter areas).

8. Minority and community action groups which wish to determine the implications of government and industry actions and policies on their organizational goals and to decide what directions should be fought or lobbied for.

9. Housing sponsors such as develops, communities who must purchase off-the-shelf-housing (e.g., modulars even today). In this situation, a whole new marketing function is involved. The sponsor client no longer has impartial professional advisors to develop his housing program, to design his house, to create contract documents which hold the builder to certain levels of specified quality, or to supervise construction and installation. The present state of industrialized housing leaves the buyer with little guarantee or assurance as to the quality and reliability of the product. At present, the housing manufacturing industry has poor public visability and almost no information and marketing system similar to that available to most other industries. The buyer, and especially the final user, lie bare and unprotected in the face of one of the most potentially disasterous onslaughts of poor products the nation has yet seen. It has no mechanism for comparison and evaluation. Our mechanism, if it could operate at this basic level, would provide a service to the consumer. It would then be of interest to all other participants to serve the consumer.

Qualitative System Design

The decisionmaking mechanism as described in the preceding chapters is intended to bring together background information in a systematic scheme necessary for the construction of a housing model. This task, when carried further, is expected to generate a qualitative understanding of the operational factors necessary to achieve the housing desired by society. It might be satisfactory to consider this information only in the decisionmaking process and to expect constructive steps toward the implementation of the objectives. On the other hand, a qualitative model might not be sufficient, and quantitative

information is needed. It is questionable if it is possible to generate a satisfactory quantitative model for housing regardless of its desirability and importance to the decisionmakers. With additional research the feasibility of a quantitative model will become much clearer.

The systematic presentation of the entire housing picture, as presented, can be manipulated for use on national, state, regional, metropolitan, and local levels. The complexity of the model on a qualitative basis will depend on the level of operation. It is evident that the constraints and criteria will be harder to define in a functional scheme on the national level than on the state level, and so on down the line. For example, the constraints of construction capability on the requirements of labor for housing production is not a severe constraint on the level if we assume that labor could be provided from other states to satisfy both constraints and requirements.

The potentials for implementation of a qualitative model are dependent to a great extent on the decisionmakers' attitude toward models. The credibility of a model of the type described here needs to be established, especially as far as social implications are concerned. However, it must be remembered that the approach used in constructing the model is logical and scientific, although it is hypothetically flexible. It is a management-oriented mechanism, and, thus, it will require convictions as to its validity to achieve successful implementation. In particular, housing must be viewed for what it is: a complex system consisting of many interaction subcomponents. For effective policymaking it must be comprehended in its entirety as it exists. There are countless examples of policies on all levels — national, state, local, or of private industry — which have attempted to treat or cure only one part of the housing system. The ephemeral character of the majority of these programs and the persistence of a housing problem are indicative of the inefficiency and deficiency of this approach. These efforts have been doomed to less than the anticipated level of success or to outright failure because of the so-called secondary effects which occurred. As in any complex system of interacting parts, a perturbation of one part causes reactions and relaxations in other components which, in general, are counterproductive and tend to nullify all or part of the benefits for which the policy was originally intended.

A generating system was presented in Chapter III to assist in the construction of qualitative and quantitative models of the housing system. In the widest sense, it is a systematic ordering of our thought process in attempting to arrive at a description of components and interactions of all that is implied by the term "housing." It should be emphasized that this generating

system is not to be interpreted as static, as fixed, or as the final word, but like the thought process itself it should be dynamic, evolving and refining itself as the thought process is evolved and refined through the use of the generating system. The important thing is not the final set of schematic diagrams that is generated but the ordering that the method engenders.

Quantitative System Design

Ultimately, one would wish to quantify the interactions and variables discovered in a qualitative system design of the housing model. This lessens the possible misinterpretations of the decisionmaking mechanism and allows for a scientific evaluation of its validity. This last step is important and should be emphasized in modeling of social systems. A quantitative model allows for more specific data collection and would help to indicate what data are functional for housing decisionmaking.

Much work remains to formulate a model of the housing system, whether a qualitative or a quantitative model. Much information is needed for the generation of each type of model. We were severely limited by a time constraint. It must be determined what type of model should be developed, the degree of its development, the relation of the model to the management institution, and the limitations placed on the total decisionmaking mechanism because of the attitudes of the potential users. Further effort should be directed toward the development of these models. However, even without completing a model, we have reaped several benefits and have identified many areas for study and investigation which must be pursued before it will be possible to fully implement an effective decisionmaking for housing.

Research

Research is essential to the development of a twentieth century industry. Though innovations and improvements may occur haphazardly or spontaneously without directed efforts, the chances of modernization are greatly enhanced if a concerted research effort is sponsored. Most industries that do not modernize eventually encounter difficulties, cannot face competition from adjacent industries or foreign intrusions in their markets, operate inefficiently, and generally flounder. Hopefully, one would expect the industry involved to support research relevant to its needs. In the case of housing, the fragmented nature of the construction industry prevents this on any large

scale. Thus, by default, the role (if it is to be filled) must be played by the government at least till the time when housing becomes an industry in the modern sense of the term. The government is a major customer of the housing industry both as a direct buyer and a subsidizer of housing projects. Any improvement in the design, manufacture, and construction of housing would lend to a better use of these funds, not to mention the benefits to the nation as a whole and the American people in particular. Much mission-orientated research is needed, but care must be taken not to exclude nonmission-orientated investigations that show a promise of application at some future date. That the shortest distance between two points is a straight line may be a geometrical truth, but it is not generally the best design policy or problem-solving mechanism. Such a linear theory of problem solution implies that one knows the answer to the problem — this is not the case in housing.

Discipline Oriented Research. Any research effort directed towards housing must include the establishment of housing-related research institutes, the training of personnel in the housing field, and the employment of the capabilities of existing governmental, industrial, and private research institutions which have potential resources which could be directed to housing problems. In the research function (Chapter III) of the housing model, we have indicated a vertical organization of housing research by classical disciplines: technology, social engineering, management sciences, legal, political, and economic sciences, and environmental investigations. Investigations must be carried out on all these aspects of the housing problem. An approach which is technologically deficient or wholly technological will not be sufficient. Some examples of needed studies in these areas are indicated below. This list is not all inclusive, but meant to be representative of the effort needed.

Technology

- Applications of remote sensing and other continuous data collection schemes to housing.

- Study means of transferring and adapting technology from more advanced sectors to housing.

- Integrated design of lightning, heating, and cooling subsystem.

- Design of fire-resistant material and fire warning systems.

- Determination of material characteristics important to housing design and development of material efficiency criteria applicable to housing design.

Legal, Financial, and Managerial Sciences

- Study means by which certain institutions such as pension funds could invest their capital in housing.

- Development of management systems for efficient distributions of housing components.

- Continue research on building codes, zoning, and standards related to housing.

- Development of performance criteria for zoning and land use.

Social and Environmental Engineering

- Identification of sociological factors that inhibit technological innovations in housing.

- Relationship of life styles to housing needs.

- Environmental effects on life styles.

- Definition of housing quality in terms of human needs.

- Determination of social parameters that effect housing needs.

- Relationship of life-cycle stages to housing needs.

Engineering Design Teams. Though the above-indicated studies are necessary for an understanding of housing as a complex system of interacting components, they will not in themselves be sufficient. Because of the interdisciplinary nature of many aspects of housing, a horizontal organization of research is imperative. Interdisciplinary engineering design teams must be organized to handle many problems. We have in the course of our study identified many such areas for future team study. Several of these are presented below. As in the case of discipline related investigations, this list

is only representative and not all inclusive. As one continues studying housing, more such efforts will be uncovered. These should be judged on their relation to the overall housing system.

Integrated Design of Living Units. At present, it is safe to say the living units are not designed in any engineering sense, but are assembled according to a rigid set of rules. From an engineering design viewpoint, a house design should be integral. All factors (technical, human, sociological) should be considered at all levels. The needs of all users should be specified and the house design should be according to those performance specifications.

Without such a designed living unit, there is little possibility of introducing efficiently new housing programs, new financing, new performance requirements, and new codes to meet future housing needs. Innovative technology and design should enter as a means of solving various problems which arise in the design: life cycle needs, flexibility, resource conservations, environmental harmony, and design efficiency. The design of an individual unit involves many more complex factors than are usually considered, and, thus, would require the most modern management technology which would include, but extend beyond, the actual manufacturing processes. We propose to use innovation, not only technological and not for its own sake, but all that is required by the complex combination of factors that are involved. The housing system is hierarchical; inputs must come from all levels. The design of a living unit is not suggested to produce an actual end product, but as a methodology which will illustrate in concrete terms the many facets which must be considered. Tradeoffs must be justified by rational statements. If there is no reason, theoretical or experimental, for a decision, research should be suggested.

Information System. An information system can be considered as the backbone toward the implementation of a decisionmaking mechanism for housing. The key activities of the information system are analysis, interpretation, synthesis, evaluation, and formulation of information for use by the model. Thus, the objective of the information system is the utilization of existing and generated data in the formulation, operation, and upgrading the model for accurate, efficient, and up-to-date performance. A schematic diagram of the responsibilities of the information system is shown in Figure IX-1. In addition, the information system will indirectly focus the attention on the areas in which research is needed for the improvement of operation of the model.

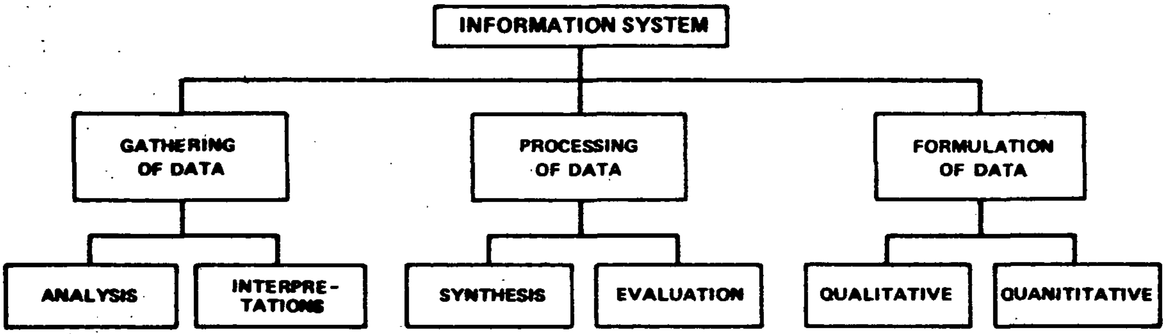


Figure IX-1. Information system activity chart.

The study prepared by the Auburn System Design [IX-1] is a comprehensive document on the criteria, constraints, and requirements of an effective information system. This is proposed here for adoption by the decisionmakers in organizing an information system that will be responsive to the model described in this document. This data bank on housing can also render a great service to all concerned in this field.

A housing information system should include an inventory of the characteristics of the populace and of the residential environment.

Also, technical data and information necessary for the implementation of housing programs and projects should be included. The relation of the housing programs and projects should be included. The relation of the housing information system to existing or proposed urban and technological information systems and sources should be explored.

Criteria Functions. After the elemnets of a model have been identified and the interactions among the elements determined, it is necessary to describe in a quantative manner (i.e., with equations) these interactions. The mathematical description of the model is one of the more difficult parts and at this point a considerable number of tradeoffs must be made. The two choices are between a model which is sufficiently sophiscated and can accurately describe the desired system and a model for which the mathematical relationships can be described and for which the necessary data are available. These tradeoffs may result in a significant reduction in the complexity of the model, although the essential elements cannot be descarded.

The forms which the mathematical relationships take are open to considerable debate and because of the usual complexity of social systems are difficult to validate. The construction of the relationships depends to a great

extent on the experts in a particular field and on the data which is available. As a final step, it is necessary to establish the parameters which appear in the relationships.

The amount of effort which must be exterted in the development of the relationships and the data will vary considerably with the use to which the model is put. For instance, an economic model to be used for a specific area and over short time periods could perhaps use linear functional relationships, but would require a very accurate base data. Conversely, a model being used to evaluate policy decisions at the national level over long time periods should have considerable attention paid to the functional relationships. Base data in this latter case would not be as critical as in the former case. For this phase of the implementation process, teams of experts on each part of the overall model to generate the relationship functions between input and output must exist. Some of these experts will require multidiscipline interactions to formulate the inter-relations between each submodel. There might be alternative correlations in the mathematical functions depending on the scope of operation of the model. The team in charge of this task will be required to maintain active participation in the model operation, feedback, and upgrading with time.

Total Cost-Benefit Analysis. Construction of housing is not an isolated industry in the United States. Even in a technological sense, it has become so large that it is capable in itself of causing large changes in the markets of its suppliers. Lumber is a particularly good example of a large industry interdependent on housing. In many parts of the country, a plethora of single-unit tract houses has occupied such a swath of territory that the housing industry has actually been felt in overall land-use patterns. In turn, the spread of these homes and their occupants has become so widespread that the highway, automobile, and mass transit industries have felt the effect. Each worker requires an automobile to reach his work. These, in turn, make highways and freeways desired and the low-density patterns combined with a wide margin in traffic patterns make mass-transit systems almost useless.

This spread of effects from housing into other industries and then into the surrounding community is paralleled by a ware of effects spreading out from housing in a sociological sense. The house itself is not without effect on its resident. The layout of housing can create patterns in community living, and housing density is certainly reflected in life styles of the residents.

It would be desirable if all of the effects of a decision in housing could be evaluated. This total cost/benefit analysis should cross many disciplines

so that all of the economic, sociological, and environmental costs and/or benefits could be analyzed and their effects studied not only with respect to the first direct user but in the surrounding community as well. Even external agencies and potential future users could be covered in this analysis. A multidisciplinary team working in this area would require expertise not only in the areas of materials and construction technology but in sociology, institutions, and resource planning as well.

REFERENCES

IX-1. UNISTAR, User Network for Information Storage, Transfer, Acquisition, and Retrieval. Report Prepared under NASA-Auburn-ASEE Summer Faculty Fellowship Program in Engineering Systems Design, Auburn System Design Group, NASA Contract NGT01-003-044, Report No. CR-61333, 1970.

CHAPTER X.

CONCLUSION

CHAPTER X. CONCLUSION

The faculty fellows were heavily dependent upon massive inputs in *information presented by an impressive array of knowledgeable housing* professionals, and upon selectively intensive readings. Insufficient time prohibited the indepth study required for comprehensive research of the complex phenonema entitled "The Housing Problem."

The conclusions and findings contained in this report are based not so firmly on exhaustive research as upon the concensus of shared experiences and the professional backgrounds of 20 faculty fellows. However, several facets have been brought into focus with sufficient clarity for conclusive presentation.

Program Summation

It has been found that no currently available source exists that clearly quantifies or qualifies the extent and character of the housing problem. Information scanned was normally fragmented, undocumented, opinionated, and *often contradictory. The need exists for timely collection and functional dis*tribution of documented housing data.

Satellite surveys designed to provide essential housing data coupled with efficient information management systems (such as suggested in UNISTAR, NASA CR 61333) offer unusual promise and should receive intensive study and pilot program implementation.

Increased coordination of housing programs within and between federal agencies is essential. The multitudes of housing programs sponsored by the many agencies defy comprehension and effective coordination. Few, if any, understand the decisionmaking process in housing or the effect of any decision upon other housing programs. The need exists to create a systems model illustrating an effective decisionmaking mechanism for housing.

The suggested model contained within this report, with further development and refinement, could quantify and qualify housing industry interrelationships. It could, in illustrating perturbations within segments of the model caused by varying the inputs to any segment of the model, suggest alternative

programs of increased desirability and efficiency. The need exists to continue the development of a decisionmaking mechanism (a model) for housing.

Critical to the development of such a model is the need to unify the national housing programs into a comprehensive system. A need exists to create a mission oriented management agency to coordinate all national housing programs.

The average housing contractor operates an under-financed high-risk venture. Innovation generates increased costs and threatens profits. Development of physically sophisticated building systems cannot be supported by the existing housing industry. The need exists to create a National Building Research Institute sufficiently funded to create, field test, and develop markets for building systems of increased sophistication.

Physiological and psychological reactions to environmental enclosure have not received significant research effort. This condition can largely be traced to insignificant funding of research within the man sciences as compared to the physical sciences and to classical organization of the man sciences. Man's needs must be known. The need exists to intensify field and laboratory research on the physiological-psychology of human reactions to environmental enclosures.

Housing is but one segment of the larger problem of creating land-use policies that produce human and natural environments of the highest sustainable quality. The need exists to create demonstration new towns of differing life styles to evaluate high-quality sustainable environments. There, new-town demonstrations should include but not be limited to the following:

1. Self-sufficient new towns.

2. New towns within towns (rehabilitation and regeneration).

3. New towns paired with existing towns (cooperative development).

The scope of the faculty fellows research topic was too broad for indepth development within the allotted time. The need exists to develop sponsored research on specific problem aspects to more clearly define manageable successive research efforts. Essential to interim and successive research are (1) the quantitative and qualitative development of the suggested

model for decisionmaking mechanism in the housing industry, (2) the development of a documented literature review library, and (3) cogent problem statements for suggested research.

An expanding population of rising environmental expectations threatens natural resources and energy sources. The need exists to create more by using less. Considerable success by NASA in the designed optimization of minaturized integrated systems to support life in alien environments suggest high-potential returns from the funded demonstration of transfer of space technologies to housing problems. The need exists to authorize and adequately fund NASA tehcnology transfer programs to housing problems.

Suggested Research Topics

The following is a listing of some of the many possible research projects in the area of housing in which an orgainzation such as NASA can make significant contributions:

1. A need exists to determine a definition of housing quality, first, with respect to the physical characteristics of the house and, secondly, with respect to how well the house contributes to the overall quality of life of its inhabitants. Some measure of what constitutes substandard, dilapidated, or inadequate housing must be devised.

2. An investigation leading to a definitive determination of which houses should be rehabilitated as opposed to replaced and the development of a methodology for the cost/effective approaches to rehabilitation and the prevention of deterioration (maintenance).

3. A study of the feasibility and advantages of an open system as opposed to closed system in housing. Open system is defined by a set of components that are functionally and dimensionally compatible.

4. A study to determine the required reforms in building codes, housing codes, zoning codes, standards, and specifications as related to housing. This study should be national in scope. Possible benefits include cost reduction and the encouragement of using innovative materials, methods, and equipment.

5. A study of how to utilize the NASA developed principles of logistics in the home building industry especially by the conventional stick builder and the industrialized housing manufacturer.

6. A study to determine the feasibility of government sponsored land development and the selling of lots at cost (or less) to qualified low- and moderate-income households. It has been stated that the major housing barrier is the high cost of land which results from its development and its appreciation because of speculative land investment.

7. The development of variable alternative living units including performance requirements and demonstration hardware designed to provide maximum choice of housing units at minimal initial and long-term costs.

8. The development of management systems for the efficient distribution of housing components.

9. A study of power use, power requirements, and power generation throughout the United States to determine the extent of the so-called power crisis and the present and projected needs for power and the capability of the industry to supply the required power. A major emphasis of this study should be the development of new power sources such as the microwave transmission of solar energy.

10. Satellite surveys and computerized monitoring of changing urban growth and natural resource patterns.

11. The development of quality control and assurance policies and procedures for the evaluation of constructed housing units.

12. The integrated design of lighting, heating, and cooling subsystems within the home coupled with the investigation of incorporating an operational power generating unit within the home.

13. An investigation of water usage in the home with reference to its uses, standards required by use abuses of use, its conservation, dispensing methods, and its recycling (within the home).

14. Reduce the cost of converting brackish water to potable water. This is a serious problem in many small communities with deficient water supplies. It has been estimated that this cost must be reduced to about \$0.5 per 1000 gallons.

15. Investigate the feasibility of locating, within the home, a system for the treatment of home generated wastes, at least for the primary treatment of such wastes.

16. An investigation of Fire Safety Standards as currently defined with a view toward updating and revising them in keeping with new developments in fire-resistant and fire-retardant materials.

17. The design of an early warning fire detection device for home use.

18. The use of flat conductor cable (FCC) and/or low voltage control circuits in new and rehabilitated residential construction.

We must build cities and buildings that sustain the best human and natural environments. A need exists to establish pollution standards and enforcement powers to protect our resources. In this area, NASA's remote information-gathering capabilities could be instrumental.

APPENDIX A.

SUMMARY OF SPEAKER'S SEMINARS

APPENDIX A. SUMMARY OF SPEAKER'S SEMINARS

The essence of each talk as interpreted and recorded by the faculty fellows is given in this appendix. No attempt is made to quote remarks made by each speaker and in some instances the opinions of the fellows are an integral part of the summary. The summaries are arranged in chronological order.

TECHNOLOGY UTILIZATION

Roy G. Bivins, Jr.
Project Manager
Technology Applications Teams
Technology Utilization Division
NASA, Washington, D. C.

The sequence in technology utilization involves identification of a problem and leads to documents which stimulate evaluation.

Congress is encouraging industrial and engineering companies to apply NASA spin-off technology to today's problems. Establishment of the NASA Data Bank will encourage proposed uses of new information with publication of information briefs of new and innovative ideas. Centers will be located to make information better available from data banks and will be systematically updated. Teams will be organized to review information which may be applicable to today's needs.

AN OVERVIEW OF HOUSING

James Simpson
Housing Consultant
Arlington, Virginia

These following points are intended to recap some of the relevant portions of the questions and answers that were exchanged during the seminar:

1. Construction Costs.

a. There is little motivation to lower costs since the architect, builder, and banker often receive their return as a function of the cost.

b. Construction costs are rising at a rate that eliminates low-cost housing for low income families.

c. The FHA-supported market now includes more baths, dishwashers, etc., all of which add to the cost.

d. It will be difficult to develop unit costs that are less than those currently obtained by the 2×4 dry-wall methods used today. There must be a demonstrated demand for other materials before the supply industries will respond.

e. The lowering of costs is considered by Simpson as one of the two major problems facing the industry. The other problem area is fire prevention.

2. Environmental Considerations.

a. Low-income people want a voice in the entire design. For example, they are reluctant to accept bare-brick interior walls if they feel they are provided only to reduce costs.

b. High-density high-rise is not an acceptable solution at this time. This relates to family control of children and the desire to be "next to the land." It appears that any complex of housing should offer several alternative living styles. Finally, the cost of land has an effect on the desirable density.

c. People want to determine their own tradeoff between quality and cost. This allows individual determination of which items are important; e.g., plumbing, space, decor, etc.

d. Noise is a problem that must be considered in the overall design.

3. Financing — The federal policy of using the mortgage market to control the economy tends to put the housing industry slightly out of phase with the rest of the economy.

4. Industrialization.

a. This is a logical step in cost reduction and the trend for increased activity is demonstrated by the 300-percent increase in the last 2 years in the number of industrial builders which now stands at 750.

b. Some states are enacting special controls for industrial housing with California as one of the leaders.

TECHNOLOGY UTILIZATION

Richard Foster
Director, Technology Management Group
ABT Associates, Inc.
Cambridge, Mass.

Mr. Foster covered the following topics in his presentation:

1. The problem given ABT Associates by NASA.

2. The method developed and used at ABT Associates for application to the problem.

3. A list of specific examples of technology transfer initiated by ABT Associates.

4. A list of technical problems identified by members of the International City Managers Association.

The problem given ABT Associates by NASA is stated: "How can technology developed for one context (aerospace) best be transferred for use in another context (social problems)." Emphasis is placed on producing demonstrable results in the short run as a means of establishing credibility for the problem solving effort.

Important aspects of method development include:

1. Successful cases of technology transfer were documented and analyzed. One example cited is the transfer of filament winding processes from the aerospace industry to housing.

2. The process used by ABT Associates includes the following:

   a. Identification of problem areas.

   b. Matching NASA technology with problem areas.

   c. Feasibility development of specific innovation for new context.

   d. Stimulating interest on the part potential users and producers.

   e. Assisting in acquiring purchase and production commitments.

Examples of specific applications of NASA technology initiated and/or developed by ABT Associates and cited in the presentation are listed below:

1. Minature electrochemical sensors for smoke detection.

2. Intumescent paints for fire protection of surfaces.

3. Intumescent spray-on mastic for fire protection of steel structures.

4. Foamed asbestos for fire protection.

5. Nontoxic plastic foams to replace urethane panel cores.

6. Chemically treated laminated corrogated cardboard with increased structural and fire resistant properties.

7. Low voltage wiring for residential construction.

8. Extendable-retractable boom for automatic garage door operation.

9. Ultrasonic torque wrench for testing tension on bolts in steel construction.

The list of critical problems identified by members of the International City Managers Association include the following:

1. Disposal of toxic and flammable materials.

2. Protective clothing for firemen.

3. Powerline fault detectors.

4. New fire hosing and hose coupling.

5. Automatic fire-hose pressure regulator.

6. Fireman's life-support systems.

7. Fiber optic device for reading impression on paper.

8. Innovations for subsurface detection of underground discontinuity.

9. Police command control systems.

10. Nonemergency patient monitoring systems.

11. Emergency patient monitoring systems.

12. Police body armour.

13. Firefighting command control systems.

14. Pavement stripping for roads.

15. Electronic traffic counter.

16. Underground pipe detection system.

TECHNOLOGY UTILIZATION

David Pellish
Director of Building Research and Technology
New York State Urban Development Corporation

Pellish stated that housing is the most urgent problem. That is the key to his operation. People are housed but poorly housed. His goal is to get units built, and he appears to be tactful and persistent enough to get action.

He pointed out that housing money is scarce, resources available are short, and they are used in an inefficient way. Pellish questions the approach taken thus far in regard to the ecology and environment. The point was not entirely clear but in support of it he questioned: "Are we using more water than we need?" "Is water use based on old technology?" "Since copper (or other materials) pipe is a premium material, why use larger sizes than absolutely necessary?" i.e., reduce waste of construction materials.

Pellish wants and supports the technologist utilized to the utmost in the construction industry.

The Urban Development Corporation (UDC) provides a most unusual and beneficial "service" to the technologist. It "runs interference" for innovations. This is an essential, practical matter since innovations are difficult to apply. Most housing-related industries and agencies operate on the principle of not invented here (NIH). This includes banks and government agencies. Pellish suggests that the government needs to take the risk that private industry cannot.

His colleagues call his action the "Pellish Plan." In way of observation, there is a deep personal commitment of men such as Pellish to provide a workable housing solution which upgrades the community.

These men make a noticeable dent in the surface surrounding the maze of the housing industry.

Pellish listed 10 innovations for cost saving:

1. Swiss Plumbing System — Eliminates vent. (Code inspectors balked; therefore, for innovations you must go to court but most constructors will not. Public agency can try it and after it works, go to code inspectors and change code.) The associated problems are as follows:

   a. Cycling of water.

   b. Sizing of fixtures.

   c. Abuse of water use.

2. Fire Safety Innovations by Design and Warning — Fire safety is considered to be of prime importance in New York and environs but may be of secondary importance in other areas of the country. The associated problems are as follows:

a. With high-rise units, fully air-conditioned, there is no immediate evacuation possible; therefore, tight smoke and noxious gases stay in and elevators use heat-sensitive control and cause unit to seek the burning floor.

b. Fire safety standards differ so much that fire safety is questionable, but nobody has complained.

c. Fire insurance companies are interested in property safety, not people safety.

d. Adjust standards; e.g., a one-story school should not be 100 percent fireproof - cost saving.

3. Balance the useful life of mechanical systems in-house — Be able to change electrical and mechanical systems easily; e.g., plug-in. Offer tenant space (envelope) and let tenant buy (mechanical and electrical) parts needed. The associated problems are as follows:

a. Too many components (wires, pipes, and ducts) inside walls when mechanical systems wear out.

b. A 40-year mortage but a 20-year life for electrical and mechanical systems.

4. Adjust job classifications and wage rates — It is ridiculous to pay electricians rate to someone to unload air-conditioners and deliver them to work location. It would be more desirable to buy from "Sears" the plumbing, heating, electrical, etc., subsystems.

5. Signals, communications equipment improvement.

6. Joining of wires and pipes in modular construction. For example, replace rubber tile at edge of floor by electrical strip.

7. Improvements in cost and safety for connecting mechanical systems from floor to floor. For example, quick-connect plumbing, snap-on or chemical weld (butt joint) of plastic pipe.

8. Use industrialization in the brick-laying trade — Laying bricks without scaffolds by prelaying panels and hoisting into place. The associated problem is that some workers fear loss of job, but on the contrary, since more units can be built at a lower unit cost, and there would be more work projected.

9. Use a production scale for demonstration of cost savings — By the model city (small-scale) approach the per unit cost is too high to justify; i.e., do not try to sell an innovation on the basis of a prototype or experimental unit. (Operation Breakthrough does not have enough volume to demonstrate cost savings. UDC has 2400 units in Rochester, 10-percent elderly, 20-percent low income, and 70-percent moderate income.)

10. Sociological study — Get a better understanding of the needs of the families for whom housing is designed and then translate these needs into physical building standards. (HUD has 30 years experience, but no people are working specifically to get new innovations started.

Pellish commented additionally on development of standards. For example, the 50 ft^2 minimum living area required per person was based on the standard 8-ft ceiling with a minimum of 400 ft to minimize tuberculosis transmission. Thus, standards were devised from reasonable requirements but are not updated. Therefore, update standards if you intend to enforce them strictly.

Some closing comments and points are as follows:

1. Welfare Island, heart of NYC, 5000 units, no cars.
2. Pruitt Igo - did not anticipate social problems.
3. Try mobile homes for relocation with movable partition.
4. Try to get flexibility in utilities.
5. Anticipate the problems of housing so that standards may be set.

AIA VIEWS HOUSING

Don Conway
Director of Research Programs
American Institute of Architects
Washington, D. C.

Mr. Conway stressed the need to consider the "people (or user) problem" in housing. He pointed out the pitfall of viewing the housing problem as a purely technological one.

In his presentation he made the following major points:

1. Most buildings, with the exception of warehouses, barns, etc., should be defined as behavior settings for human activity.

2. There is a growing awareness that there is a little-understood relationship between human behavior and physical setting.

3. The user should be allowed to solve as many of his housing problems (i.e., manipulation of his own space, etc.) as he is capable of, using the professional as a resource person.

4. Present planning imposes a static process on a dynamic problem. What is the proper strategy for housing in a changing situation?

5. What is the social or human cost of living in a given environment and how can it be evaluated in the post construction phase of housing?

6. A feedback system from the housing user to the housing designer now exists. The feedback that does exist now comes mainly from housing managers.

7. An alternate role for the design group could be the concern for human ecology; i.e., the design of an environment to produce a better fit between human needs and physical surroundings. These needs should be considered in two categories: namely, (a) perceived and (b) real.

8. Design flexibility into housing hardware to encourage an individual approach in housing. Is it possible for the user to program his own house? This would still require that the user be informed about his possible alternatives.

ECONOMICS OF HOUSING

Herman G. Berkman
Professor of Planning
New York University

Professor Berkman's presentation was divided into two parts. During the first part of the morning, he mentioned two studies of Huntsville which he had directed. Both had to do with the impact of large influx of highly trained technologists on the community. For the second part of his presentation, Dr. Berkman spoke on the economics of housing and made the following points:

1. Housing competes for capital. Alternate uses are more stable and less risky; therefore, institutions have been set up to provide financing (the secondary mortgage market).

2. The conditions on which credit is made available form the single most important factor in housing.

3. Most of the money made in housing is made in the financing of homes and land speculation.

4. Because of the point system, the actions of the federal financial agencies actually have little influence on the actual interest rate the buyer of housing pays.

5. It is probably impossible to reduce the cost of housing in any significant way, because if the cost of the physical housing unit is reduced, the cost of land on which housing is located can be expected to rise concomittantly.

6. Building cycles typically go contrary to the rest of the economy and are more severe in amplitude.

THE SYSTEMS APPROACH, A CENTURY OF PERSPECTIVE

Samuel E. McCrary
Technology Utilization
Marshall Space Flight Center

Mr. McCrary's talk was basically a review of his professional experiences and how these experiences were influenced by the systems approach.

His father worked under David Taylor before the turn of the century. Taylor's group began to use a systems approach to ship design. Later (1926), Jessie Lunsford demanded objective performance specifications for ship systems. McCrary considered this an important advance. After a variety of jobs (CCC construction, general electronics, etc.), McCrary worked for Lunsford at the David Taylor Model Basin (1940). He found that the use of performance specs resulted in rapid (6 months or so) development of many new engineering materials. In 1956, he moved to Huntsville, and later got involved with NASA and the Saturn Program.

Mr. McCrary stressed the point that in the systems approach, both an adequate technological background and a proper attitude among the workers are important. He also mentioned that few faculty members have been involved in the systems approach and that this program presents an excellent opportunity for us to transmit this knowledge to our students. One point which was especially interesting was the use of a "tiger team" of technological experts who troubleshot groups having difficulty.

A discussion session followed. It largely consisted of reflections by Mr. McCrary and by Herman Hamby on their NASA experiences with the systems approach. Their most salient point was that intellectual honesty and objectivity is of prime importance.

REGIONAL HOUSING

Woodrow B. Peek, Program Coordinator
Top of Alabama Regional Housing Authority
Huntsville, Alabama

Mr. Peek made the following points in his talk:

1. Need simplification in housing authorization administration. Too much paper work.

2. HUD funded 153 different housing programs in 1971.

3. Top of Alabama Regional Council of Government (TARCOG) works with the people they serve, outreach workers, and local contractors. Simplified housing need handouts produced good results.

4. Forty percent of homes in the TARCOG area are substandard. Eight to ten thousand units have been justified in the area.

5. HUD 235 Program — Subsidized home purchase program.

6. Public housing well received in Top of Alabama. Home ownership has stimulated work incentives.

7. Housing design — Selected from experience tested design that the builders are familiar with.

8. Costs — HUD sets income levels and constructuion costs for each area. No subsidy for property tax, utilities, and services. Twenty-year mortgages.

9. TARCOG hopes to become a clearing house (through county representation) for all subsidized housing programs in Top of Alabama. Next move, a 6000-acre new town (1200 people, 200 units per year). Hope to coordinate all amenities (mass transit, sewage, water, etc.).

10. High acceptance of public housing program possibly due to TVA successes in servicing the population and education of recipient population by Top of Alabama Regional Housing Authority (TARHA).

11. A foam sandwich panel house is being built in Huntsville for the Navy.

12. TARCOG aggressively seeks industry and provides attractive industrial incentives.

13. "All that is needed is money — 63 percent of the tax dollar goes to Washington, and I want my part of it."

14. "Ten years from now we can have just what we want if enough of us put our shoulder to the wheel."

15. Anticipates initial resistance but eventual conversion of traditional contractors to modular housing. Anticipated volume of modular construction too great to be successfully resisted.

SOME HOUSING PROBLEMS

Dean Matthews
Executive Director
Top of Alabama Regional Council of Governments
Huntsville, Alabama

Problems in housing:

1. Houses can be built, but administrative and financial red tape is complicated for the builder. Elimination of red tape will help achieve efficiency.

2. An optimal city is of less concern than handling many daily, routine concerns.

3. There are too many organizations involved in broad housing decisions.

4. Why not devise simple systems approach for "man on street" in dealing with regional housing?

SPACE STATION STUDIES, MSFC

James B. Bramlet, C. O. R.
Program Development
Marshall Space Flight Center

Mr. Bramlet gave an illustrated presentation showing how the space station concept was evolved. Some of NASA's hard and soft technology, as evident from Mr. Bramlet's talk, could be carried over into the housing industry.

E. J. Campbell, Midwest Div. Sales Mgr.
Robert Cooper, President
Dillard Powell, Vice-President for Engineering
Missouri-Continental Homes, Inc.

Mr. Campbell indicated that Continental Homes currently has three plants (in Va., Mo., and N. H.) and will soon have a fourth. They erected some 845 homes last year. Operations extend to 23 states, each plant servicing a 300- to 500-mile radius (average of 263 miles from factory). The company deals with construction and guarantee of the dwelling, but does not enter into land acquisition or other ancillary activities. They produce 15 architectural designs, which, with options, create 1590 house variations. Another activity is similar business in small office, store, bank, and classroom structures.

Continental uses standard, manual frame house building methods to construct 12-ft-wide modules in factory. Transport to owner's foundation is by truck. They use special track and wheel system to set the modules on foundation, and a crane is used for two-story apartments. The benefits of their method are as follows:

1. Guaranteed cost control.

2. Controlled delivery (obviates vandalism).

3. Savings retrade and labor unions.

4. Quick turnover yields savings on building financing.

5. Quality materials.

6. Precision engineering.

7. Architect-approved design; will soon have UL approval.

8. Marketing help (national magazine, FHA submission; market-tested designs).

Can set up a house in 1 day, could promise to set it up in 72 hours, but it usually takes about 2 weeks because of delays in subcontractor scheduling.

Continental homes is market-oriented and moves with, vis-a-vis ahead of, the market. Gets once—a-year feedback via best salesman.

Miscellaneous items:

1. Uses hot water baseboard heat but have not solved air-conditioning question.

2. Build to more than 350 different codes.

3. Cited codes as a chief problem, and could save about 10 percent per house with a uniform code.

4. About 28-house-per-week capacity currently.

5. Innovations relate to transport methods and factory layout.

Mr. Cooper feels modular housing is the most modern concept of housing. It began as pre-cut housing and has evolved into the present technology. Pre-cut was a compromise, but nearly all the work on modular housing is done in the factory. There is greater value per dollar spent.

Their first completely factory-built home was done in 1962. Modular homes are particularly applicable in areas where there is a shortage of skilled labor. Most are shipped in two to four sections and are complete except for joining at site and connection of the mechanical aspects. Houses up to 2000 ft^2 in floor space are produced.

Continental Homes have expanded in New England and the midwest as well as going commercial. They now produce business structures and educational buildings and have become a part of the Weil McLain conglomerate. They have shown a profit every year.

Continental Homes meet all FHA, state and local codes. Although mobile homes are more profitable, they usually do not meet the code requirements.

Since it is a tough, competitive industry, good management is essential. The modular home industry cannot try to compete in all areas of housing. They aim primarily at the large majority who want conventional styles. The house must appeal to the buyer. The low-income people want a house that looks like yours and mine — it must be attractive to the buyer.

He admitted that without government subsidies for housing, they may have been out of business by now.

Mr. Powell showed slides of the straight-line production method that Continental Homes utilizes in their manufacturing process. He discussed the firm's development since its organization in 1962 and his part in it as the developer of technical methodology and the holder of the patent rights. Some questions about these operations were held as proprietory. Generally, a box is built up in the plant using wood frame with gypsum board and plywood and then completed with electrical and mechanical systems. Modules are then shipped to sites on special company trucks. Individual modules are then attached to others to create homes. These trucks are considered by Continental Homes to be a very important aspect of their overall marketing program.

THE RESTON PROJECT

Joseph Intermaggio
Professor of Planning
Virginia Polytechnic Institute

Dr. Intermaggio believes that the wealth of this country is in the cities. The cities are on the verge of a severe national crisis in productity and resources with no real satisfaction in the society. He cautioned that there is no quick answer or solution to these problems.

Dr. Intermaggio is an advocate of growth organizations that are manageable and governable. The new city of Reston was discussed in detail. The success of this project in the social interaction and thoughtful use of the landscape are in essence the innovations that our cities of today are lacking.

Discussion of the Birmingham Project followed the suggestion by Dr. Intermaggio that the Auburn Design Group take such a project as the topic of the systems approach to be presented to NASA. The negative forces for this

project were cited as (1) pollution control, (2) interaction with the closeby Birmingham community, (3) slow population growth in the area, (4) lack of basis for good living in the area, and (5) the rough terrain and discontinuous mountain ridges characteristics for the proposed location. The positive forces under consideration were quoted as (1) the existance and availability of water and sewage disposal from Birmingham, (2) governmental geography, (3) metal labor forces of fairly good income in the area, and (4) potential for practical objective demonstration project for open community occupancy for black and white.

Because of different points of view and political reasons, various governmental bureaus and red tape are obstacles to implementing technological advances in housing.

Suggestions for building a city are as follows:

1. Concerned individuals should lead out in the planning stages.

2. Developers should be assured of adequate capital to realize the dream.

3. Developers should possess sufficient talents to build a city.

4. Developers should avoid conflicts with established governmental units.

5. The new city should not be established as a separate governing unit.

Limitations in building communities are as follows:

1. High interest rates.

2. Current land costs.

3. Developers lack risk capital.

4. Expensive special studies research, necessary before beginning construction.

Advantages of new communities include the following:

1. More abilities to overcome change.

2. Higher quality of services and life more likely in future.

3. Lower cost of services.

4. Have more political impact.

Limitations of new communities oftentimes include boredom for children. However, all potential problems can be avoided or minimized by better planning management.

CAMDEN HOUSING IMPROVEMENT PROGRAM

Jerome I. Weinstein
Executive Director
Camden Housing Improvement Projects

The problem of low-cost housing may be common to all industrialized societies.

Camden Housing Improvement Project (CHIP) is primarily concerned with housing rehabilitation. The instant rehab in New York costs \$38 per ft^2. If new structures cost too much, then rehab will cost even more and even though rehabilitation may be the most costly method, but then one must also consider human needs. Small-sized houses present a special problem, even though they may be structurally sound, because flexibility for change is pretty much proportional to size.

Cities may become economically obsolete and planners are unsure whether cities should be abandoned or rebuilt as they deteriorate.

CHIP was organized in the summer of 1967. Five companies provided a fund of \$600 000 as working capital, interest free. The group started buying houses for rehabilitation.

One can estimate cost to within ± 2 percent on the average as experience has shown. Bids are not competitive. Quality is wanted. CHIP does 10 to 12 houses per month and buys only vacant houses. They currently have done over 300 houses, with an average cost of \$13 000 for a three-bedroom house.

The problems are not technology, but persons, codes, building inspectors; i. e., people problems. Another large problem is trained personnel.

Other building owners are also now beginning to fix up houses following CHIP's example.

DISCUSSION OF HUD

Tom Armstrong
Assistant Regional Administrator for Metro Planning and Development, HUD
Atlanta, Georgia

Organization of HUD. Mr. Armstrong presented a general overview of the reorganization of HUD. The expressed objective of this reorganization is to make HUD more responsive to the needs of the people. Prior to 1965, HUD made no basic changes in the organization of the five federal agencies united under its roof. The regional commissioners had no power, and all instructions came from Washington. The major measure of success was the ability to spend the money allotted. Under the present reorganization, the power will be at the regional level. One problem with this plan is the shortage of trained personnel in urban planning and business appraisal; however, this should correct itself with time.

Role, Directions, and Comments on HUD and Its Programs. From a philosophical viewpoint, the major objective of HUD is equal opportunity, and the direction of its programs is towards low-income, black, Puerto Ricans, and Indian groups. HUD does not deal with individuals but only with public bodies or private nonprofit organizations.

Model Cities Program, in general, is a failure, especially if viewed in terms of construction. Public participation has not increased effectiveness. The difficulty has been in the identification of the problem by the local groups.

Revenue sharing, in general, will be beneficial to local communities. It should alleviate year-to-year funding of projects. After revenue sharing, the role of HUD will be mainly post evaluation. Major cities have experts, and medium-size communities can use consultants in planning their programs.

The acquisition of land program was a failure since, in general, a local community puts the financing of land acquisitions and the financing of the facility on the same local bond issue.

The program that provided advances for public planning (now discontinued) was a great benefit to local government at a small expense to the Federal Government.

Operation Breakthrough does not possess great possibilities for technological innovations of major significance. Its great impact will be in the awareness that codes and zoning have added great costs to housing. There are two sites in the southeast: Memphis, Tennessee, and Macon, Georgia. In Memphis, the appraisal value of a unit which cost $32 000 is $9000.

In most urban services the technology used has not changed for many years; e.g., sewers.

New cities can be built faster than new transportation systems in old cities. In theory when a city reaches a population of 250 000 it becomes self-generating. There is not much HUD can do to remove control of a new city from the county; however, it is not difficult to sell the idea on enlightened interest.

One problem with services in the south is that the south has never had a high level of public service and always has had a tradition of low taxes. It is not accustomed to paying for its public services.

<u>Legal and Financial Problems.</u> A major difficulty with most states is their inadequate constitution which prohibits debt except for defense and insurrection. This is passed on to the city. The city has developed several devices to circumvent this situation, the major of which is the special obligation bond. The method of financing these bonds usually adds 0.5 percent to 1.5 percent to the costs in addition to user fees. The philosophy of the voter is to vote no unless the issue is well publicized.

THE METHODOLOGY OF THE CREATIVE PROCESS

Julius Stulman, President
World Institute

Mr. Stulman proposed a very idealized solution to the housing problem based on the philosophy of the World Institute Methodology. The solution, which requires a quantum jump in our society, is based on development of a specialized Executive Brain Center with an interdisciplinary staff. The function of The Brain is to evaluate continuously the latest technology, resources and designs so that "sophiscated, factory built intermodular units, complete with utilities and appliances, are directly available to the consumer from a central depot."

A key to the success of the proposed solution is the development of a computer-controlled containerized handling system. Each container, after inspection at the end of the production line, is registered, bonded, investigated, insured, and is, therefore, a bondable product.

Mr. Stulman sees an opportunity for NASA to become a creative force in developing The Brain by encouraging a flow of new professionals, trained at NASA, to organize interdisciplinary, executive bodies capable of bringing their fingings to aid government, business, labor, and people everywhere.

FIREPROOF MATERIALS

Matthew Radnofsky
Manned Spacecraft Center
Houston, Texas

Dr. Radnofsky indicated that one of his jobs is the dissemination of information on fire-resistant and nonflammable materials and the encouragement of their use. This includes materials not necessarily used in the space program. He indicated that for specific space-related applications, function is most important and, second, the material must also be inflammable.

The three main fireproof materials discussed are as follows:

1. Beta glass — Made of glass strands with diameter of 3 microns. Used only for applications with no chance of abrasion. Beta glass has no durability. It will not fold, bend, crease, or burn. Coat a layer on both sides with Teflon and can use it in some nondynamic applications because of increased durability. Coat individual fibers and weave a fabric (this can be used for exterior lining of space suits).

2. Karma (Nichrome) — A metal fabric costing from \$100 to \$1500 per pound. This material has good abrasion resistance and is used as patches on strategic locations on a space suit. Karma burns in 100 percent 0_2 at 16 psi.

3. PBI — A fabric made by Celanese which has excellent physical characteristics but which costs \$150 per yard and comes only in brown. There is no better material from a functional standpoint. It is used in applications where Beta glass is not needed. PBI wears well, fells good, has good tensile strength, has high abrasion resistance, and does not burn in air.

Each of the three aforementioned materials are fabrics that are sewn together with Nomex. Nomex burns but this is okay because the heat sink characteristics of the material are sewn together. Space suits are capable of protecting a man for over 1 minute in a 100-percent oxygen atmosphere at 1500° F. The object is to minimize the risk, not necessarily to eliminate risk.

The gases given off by some materials upon burning have been discussed. Some give off chlorine, fluorine, arsenic, etc. However, it was pointed out that the most dangerous combustion byproduct is carbon monoxide.

Several other materials are described as follows:

1. Durette — A good, fire-resistant material made by Monsanto Chemical Co. It costs \$8 to \$15 per yard and is available commercially.

2. Fluorel (Reffset) — A fabric coating which is generally sprayed on. It can be used on flammable or even nonflammable materials (such as durette) to make them fireproof or impervious to moisture. This material, manufactured by 3M, is essentially an elastomer with many of the properties of rubber, only better. Polyurethane foam burns readily but when sprayed with Fluorel becomes fireproof. However, a continuously present open flame will break down the Fluorel and then consume the foam. The coating does not degrade over time and has little or no effect on the function. The fluorel can be pigmented prior to its application, and can be painted.

3. Lithoflex — A foam made of asbestos dust with a Fluorel resin binder, and it is made in Germany. It does not burn or smoke, is an excellent insulator, and costs about 20 cents per ft^2 in 1-inch-thick layers.

4. Fireproof paper — A wood product composed primarily of cellulose. It is impregnated with ammonium dihydrogen phosphate and several other chemicals which accounts for the materials' desirable properties.

5. Polyimide materials — Capable of maintaining electrical properties even after exposure to 3000° F for 10 minutes.

6. Pyrell (made by Scott Paper Co.) — Surface burns and then extinguishes itself. It stops rather than propagates a fire. Serves as an excellent insulator.

Throughout his presentation, Dr. Radnofsky gave several demonstrations on the effects of fire on many of the materials he discussed. He showed a short film on firefighting suits and a series of slides illustrating various aspects that he had discussed.

A program was mentioned in which small (5 by 5 by 5 ft) houses were constructed of conventional and fireproof materials. These houses would then be tested by burning with calibrated molotov cocktails and observing the effects. (This program is located in Houston.)

Dr. Radnofsky stated that intumescent paints are not too useful because a fire must exist. The paint serves to extinguish the fire, but the Radnofsky philosophy is centered on fire prevention. He looks at the picture as a triangle of three elements: atmosphere, ignition, and fuel. We cannot do much about the atmosphere and ignition. Thus, the main effort is to eliminate the fuel by trying to develop materials which do not burn.

LABOR RELATIONS IN THE HOUSING INDUSTRY

Charles T. Muntain
Assistant to Secretary for Labor Relations, HUD
Washington, D. C.

Mr. Muntain made the following comments:

1. Industrialized housing will give the opportunity for the labor unions to have control over a greater percentage of the housing starts. (75 percent of present housing starts are nonunion.)

2. Unions will be reluctant to change the building codes because their members have been on the committees that made the codes.

3. Unions are presently working with the trades to establish special rates for residential work.

4. Work done in factories requires less skill than work done on-site.

5. Principal problems in housing are caused by zoning and mortgage financing.

6. A national housing code is supported by HUD. Breakthrough is helping change present codes. Over 30 states are improving building codes.

7. Fragmentation of the building industry is a barrier to resolving delays in completion of construction projects. Attempts are being made to organize industry so there will be a balance of power with unions.

8. The Davis-Bacon freeze, before it was reinstated, inspired wage stabilization in the building industry.

9. The Labor International Union feels Breakthrough is a boon although there is reluctance among the majority of unions to accept Operation Breakthrough.

10. Along with the Breakthrough Program, HUD is pushing rehabilitation of old buildings.

ECONOMIC CONSIDERATIONS IN PLANNING

Richard Wyskida	Jack Stucker, Chief
Professor of Planning	Plans and Resources Group
University of Alabama - Huntsville	Marshall Space Flight Center

The Stucker-Wyskida presentation covered various points under the following subjects:

1. Development of cost estimating methodology for MSFC.

2. A computer model for estimating launch vehicle costs.

Points covered under cost-estimating methodology included the following:

1. Sources of methodology.

   a. Techniques used by other space centers and aerospace firms.

   b. Estimating theory.

2. Stages requiring special costing procedures.

   a. Conceptual stage.

   b. Preliminary design - prototype.

   c. Detailed design and production.

3. The use of manhours as estimating unit.

4. Learning curves and progress functions.

5. Identification of cost variables.

   a. Hypothesis: manhours/unit of variable functions are the same for differing products at comparable technology and complexity.

   b. Variables used included dry weight, propellant weight, thrust, density, and technological advancement.

   c. Of 11 variables tested by regression analysis (method of least squares) 5 were found significant. Dry weight was found most significant.

6. Cost value functions derived by statistical inference have rapidly decreasing projective value beyond known points.

Points covered under launch vehicle estimating model included:

1. There was a computer model developed by a NASA contractor to estimate the cost of producing launch vehicles in variations by vehicle type, size of production run, and run schedule.

2. Cost variables in the model.

a. Direct.

(1) Engineering

(2) Manufacturing.

(3) Other (propellant).

b. Indirect.

(1) Fixed.

(2) Variable.

3. Each variable was divided into rate sensitive and learning sensitive subvariables.

4. Step functions were developed for rate sensitive subvariables.

MATERIALS — FIRE RESISTANT PROPERTIES

Charles A. Wilson, Staff Consultant
Ames Research Center, NASA

The main portion of the formal presentation detailed the use of NASA technology to prevent and reduce the fire hazard in housing. Several other points worthy of mention are:

1. Disney World is possibly the best current example of the use of technology to solve problems in the construction arena and at the same time to account for ecological considerations.

2. Not very many people are actually concerned about fire safety. An example was the placement of exit signs where they are obscured by the smoke.

3. There needs to be some analysis of the rate of heat released from various materials in addition to the current tests shown in the slides.

4. Detection is important and must provide ample time to reach safety or a safe haven within the building itself. He indicated the great hazard of gases released by the fire including CO. In large buildings, escape is not feasible and havens must be included in their design.

5. Safety standards must vary depending on the housing environment; e.g., in hospitals, there must be ample time for patients to evacuate themselves.

6. On external fires, he indicated they are spread by either radiation or from airborne burning particles. (Codes are suggested that exclude shingle and shake roofs.)

7. Technology at its present level can solve many of the problems if we are but ready to pay the price.

8. Several examples of current activity were sighted including:

a. Navy's painting of bombs with intumescent paints to reduce fire hazard.

b. Coating aircraft fuel tanks to prevent ignition by tracers.

c. Coating of plastic bathroom fixtures so the plumbers can install them without burning the house.

9. Because of high temperatures near the ballasts, all combustible material must be kept away from fluorescent light fixtures.

NAS INVOLVEMNT IN HOUSING

Robert Dillion, Exec. Director
Building Research Advisory Board
National Academy of Sciences
Washington, D. C.

Most industrialized housing has failed, because a sufficiently profitable market volume has not been generated. Lustron Corporation is a notable example.

A failure to integrate housing and building has been a tragedy in U.S. housing. There is a need for a systems integrated approach to optimize production.

Problems in housing are as follows:

1. Instability in money market.

2. Inadequacies in building labor market (immobility, lack of training, etc.).

3. Materials difficulties (vanishing forests, dependence on foreign countries for some materials, etc.).

4. Present lack of clarity in what is needed in housing; should we tool up now with an anticipated future population decline in 1978?

5. Location of real housing markets is not static; it is everchanging.

6. There is a lack of proper definition of housing markets. Housing markets do not stay in one area; the market is dynamic. Modular homes are a significant change wrought by Operation Breakthrough. Prototypes are being analyzed. A dramatic activity coordination of agencies encourages, including builders, to consummate a systematized approach.

7. High costs of new innovations for housing builders. Small businessmen cannot use computers; marginal builders are in excess.

8. There are difficulties in determining future housing needs and present house stock.

a. There is continuous abandonment of cities. (Where will they then need a house?)

b. There are errors in taking census information. (What is a "dilapidated" house needing condemnation or rehabilitation?)

A national building code is not advisable and not feasible. A national building code would be even more conservative than present ones, as it would relate to adapting innovations to housing, or removing code barriers to construction.

APPLICATION OF LOGISTICS PRINCIPLES TO HOUSING PROBLEMS

John C. Goodrum, Director
Adv. Program Support Office
Program Development
NASA-MSFC

Mr. Goodrum is a logistician. Throughout the discussion it was evident that logistics is a common sense activity. Logistics is not a glamorous part of system management but is essential because there is great potential for cost saving and increased efficiency.

The concept of integrated logistics support was emphasized. Basically, the important consideration in system planning was to include logistic planners as part of the basic design team. There are many analogous cases; e.g., in power system design, traditionally the power system protection engineer was given the complete system design and told to protect the system. The task is difficult and yields an uncoordinated system. The same is true of logistics. Make logistics planning a part of the original system design, rather than completing the management system design and then, upon presenting it to the logistician, saying "here is a system, you design a support system."

Mr. Goodrum defined the disciplines of urban logistics as the following:

1. Support analysis — All other aspects of logistics are dependent on support analysis; consider maintenance, supply, and operation.

2. Maintainability.

   a. Eliminate maintenance.

   b. Make maintenance easier.

3. Supply support.

   a. Ascertain that a particular spare part will be available on the market for the products expected life; e.g., Sears - 10-year contract from manufacturer to get parts.

b. Contract for performance warranty; i.e., the product is guaranteed to perform a specific lifetime (e.g., Boeing 747 and Douglas DC-10).

4. Transportation — Packaging and handling to assure the safe arrival of products to destination.

Some topics mentioned:

If you consider logistics (maintainability) earlier in the system design, it can be done cheaper. The advantage is repeat sales and endorsements to other customers.

American Airlines developed a maintainability manual for the space shuttle.

Give the homeowner an operation manual for the home and encourage by design the homeowner to maintain his home; e.g., minimize special tools, handy shutoff valves, fool-proof plug in units, standardize parts, etc.[1]

NECESSITY OF COMMUNICATIONS

Walter Wiesman
Consultant
Huntsville, Alabama

The systems approach connot be used to solve housing and social problems in the same sense it was used to reach the moon. When systems approach was applied to the space program, there was peace and tranquility, so to speak, on all fronts of endeavor. Crossfires today would arise in all American communities on housing and social decisions of significant magnitude. This disturbance is based on economic and behavioral influences.

The interaction of the various components of the communities is essential to minimize future static. This includes the power structure to which planners should relate before developing a plan. Who are they? Church leaders, land owners, key businessmen, union leaders, service clubs,

---

1. Book on Maintainability, by Blanchard and Lowery, McGraw-Hill.

and others sell them on ideas initially. To implement a plan, find the centers of influence.

The systems approach, as a technique, is well established. The secret of its successful implementation is to include a personalized application.

This is a diverse country and a housing development that must be built for a specific locale.

ALCOA BUILDING SYSTEMS

R. W. Lisska
Aluminum Company of America
Atlanta, Georgia

Mr. Lisska indicated that ALCOA is currently working on three products for the housing market:

1. Alumiframe — An aluminum framing system.

2. Rigidwall — A load bearing formed metal panel.

3. Panelized construction with wet core — Use of building panels in conjunction with a modular unit containing kitchen and/or bathroom facilities.

Mr. Lisska pointed out that of the three products, ALCOA believes the current market acceptability of Alumiframe promises to be the highest and has the most potential at the present time.

According to ALCOA, the advantages of Alumiframe were enumerated as follows:

1. Structurally equal to wood.

2. Less labor required.

3. Field or factory assembled.

4. Less material required.

5. Dimensionally stable.

6. More economical as a system.

7. Lightweight.

Alumiframe and Rigidwall are being used on three Operation Breakthrough sites in single family homes and garden-type apartments.

The use of Rigidwall has encountered problems because of building code restrictions and the depth of the panel itself which is 2.5 to 3 inches.

The panelized construction with a wet core is being used on the Macon, Georgia, site of Operation Breakthrough. It is anticipated by ALCOA that this construction will be underway by November 1971.

URBAN DESIGN

Ralph Warburton, AIA, AIP
Special Assistant for Urban Design
Department of Housing and Urban Development
Washington, D. C.

An interdisciplinary approach is applicable to the solution of all problems, including housing and environment.

The urban design area is defined as the maximum area which advanced technology can build in 5 to 7 years.

Those who apply new innovations must first understand human needs to minimize the problems of the user. Human needs vary since we are not a homogeneous society.

European housing design is not compatible with U.S. user needs because American desires and perspectives differ from their European counterparts. There is a deficiency in housing research about normal American living habits since much has been done in researching specific groups, not much is known about the needs of the masses of normal Americans who need housing.

The user-needs thesis is visualized as a total system which includes, not only housing, but also daycare systems and consideration for total environment. Often, local governments lack in professional expertise for best handling or optimizing the overall developments of the living environment.

SAFETY IN THE HOME

Samuel H. Lowery
Teledyne Brown Engineering

Colonel Lowery's group at Brown Engineering was contracted by HUD to study safety in the home using the following methodology:

1. Establish the nature frequency and severity of home accidents.

2. Identify the causal factors contributing to fixture-related home accidents.

3. Relate the causal factors to current building codes and standards.

4. Develop revised or new building code specs in those areas which are deficient.

The group found little verifiable data on home accidents; therefore, they decided to take their own survey. Approximately 10 medium-sized cities were picked for the study. Questionnaires (3000) were distributed in each city with 1000 each to the low-, middle-, and high-income brackets. The questionnaires were distributed by doorknob hangers, and were to be voluntarily returned by an attached stamped, self-addressed envelope. (Colonel Lowry was questioned and criticized by several members of our group at this point for his survey methods, particularly the distribution and the method of return.)

The results of the survey basically agreed with some data published by the National Safety Council. In particular, the predominate accident types were stairs, tubs and showers, glass doors, windows, and other doors. These types were further broken down as to specific cause. For instance, relative to stairways, the causal factors of house accidents ranked by accident frequency were slippery stairways, steep stairways and/or narrow drafts, missing handrail, riser heights, and lighting.

QUALITY AND RELIABILITY ASSURANCE

Dieter Grau
George Butler
Quality and Reliability Division
Marshall Space Flight Center

The seminar by Dr. Grau and Mr. Butler is summarized in outline form as follows:

1. Fundamentals.

a. Assurance: our function.

b. Service: our business.

c. Flight hardware: our priority.

d. Early involvement: our main step toward success.

2. Most hardware is contracted with outside contractors.

3. A detailed description of the Quality & Reliability Assurance Program for the Space Shuttle Program followed and included the following:

a. Management plans, subcontractor controls, and audits.

b. Design criteria and review.

c. Reliability in specs.

d. Failure modes and effect analysis.

e. Maintainability.

f. Problem reporting, analysis, and corrective action.

g. Control, standardization, and qualification of all parts.

h. Testing: development, qualification, acceptance, static firing, horizontal flight, and vertical flight.

i. Certification of employees to perform required tasks.

j. Tracability of hardware.

k. Contractor procurement team procedures.

l. Fabrication, cleanliness/contamination controls, and testing.

m. Control of nonconforming articles and materials.

n. Flight test and ground operations.

o. Calibration of instruments and inspection controls.

p. Handouts of organizational charts were distributed.

ELECTRIC UTILITY CONFERENCE

Roy Barron General Sales Manager Alabama Power Company Birmingham, Alabama	Harold L. Falkenberry, Chief Power Research andDevelopment Branch TVA Chattanooga, Tennessee
H. J. Young Vice-President and Secretary Edison Electric Institute New York, New York	William R. New, Chief Market Analysis Branch TVA Chattanooga, Tennessee

Although each speaker presented some prepared remarks, it is a bit difficult to match each remark with the associated speaker where a free, open discussion is encouraged. Because the speakers tended to reinforce the remarks made by others, there is perhaps no reason to be unduly concerned about attributing the remark made by one to another.

Mr. Barron felt that the electric utility industry has a responsibility to the public to provide all of the electric energy that the public demands. He is against the idea of rationing or of setting false rates to discourage the use of electricity. Although he stressed the need to protect the ecology, within practical limits, he felt that such protection could be assured if the public is willing to pay for it. The fast-breeder reactor appears to be the solution in providing the increased energy demands of this nation for the next century or so. The energy demands of the electric utilities from a regional or national viewpoint are about equally divided among residential, commercial, and industrial requirements. Mr. Barron said the utility industry looks for a greatly increased consumption of electricity in the individual home. He also

gave an overview of how the Alabama Power Company attempts to "fill in the valleys" on the load demand and how his company uses hydroelectric and regional interties to meet peak demands. Although the heavy users of electricity are penalized for unusually high-peak demands for power, he does not foresee this type rate penalty being applied to the individual homeowner.

Since some of the discussion by Mr. Falkenberry was in answer to questions, this report is primarily a series of unstructured statements. British Electric Council is studying color schemes for warmth. He is against home power units as wasteful. Also, the repair problem could be bad. Geothermal power, where a deep hole is drilled, a blast set off to crumble the rock structure where the temperature is quite high with water being injected to produce steam is being studied. New methods for high-voltage power transmission are being studied. He also discussed some other sources of electric power that are being studied. He indicated that power consumption is doubling each decade. They still want to sell more people on using more electricity. He discussed some of the other factors in the overall TVA program. Among these, and maybe all, are the fertilizer development program, health and environment science, water-route planning, new town studies, and operation townlift. Hydroelectric power is very limited, especially in this country, but nuclear sources are great if we can develop an efficient reactor. The breeder reactor is in the development stage, but is not expected before the year 2000. He feels we are not close to an energy crisis. A fusion reactor is a possibility, but has not yet been demonstrated as feasible.

Mr. Young said that he has noted a revival of interest in solar energy in the last 6 months. Penn State, national labs, and Peter Glaser at A. D. Little are all interested. Glaser considers an area of 36 square miles necessary to provide electric power to New York City. Many people see solar energy as a future option. In answer to a question regarding the power companies' efforts to educate for better use of power, he replied that, first, the current power supply problems are temporary, but further, Consolidated-Edison has redirected advertising efforts toward energy conservation. Industry is trying to fill valleys in power-time curve. Consolidated-Edison tries to sell off-peak load, but cannot control appliance advertising. Consolidated-Edison has undertaken a study of uses of thermal waste in the New York City area with nothing positive to report. A meeting will be held in Gatlinburg this October regarding thermal waste problems. Energy supply industry is capital intensive. It takes about $4.50 investment to yield $1.00 of annual revenue, as opposed to $0.50 per $1.00 for commercial ventures.

Forecasting in the power industry has proven to be very accurate. A forecast made in 1949, reaching to year 2000, is off currently only 0.6 percent. In 1970, the per capita use of power was 5000 kW-hr/yr; it will go to 23 000 kW-hr/yr in 2000. Some assumptions in forecasting are (1) the nation will continue to increase efficiency in use of energy in production and in applications and (2) the five major markets of lighting, stationary motors, heating, transportation, and the electrochemistry industry will continue to be in increasing demand. Mr. Young suggests, for the future, a dual mode of transportation: (1) private (electric) vehicle for intermediate distances and (2) a plug-onto automated highway for longer ranges.

Mr. New was one of four electric utility representatives who participated in a generally informal presentation of problems, activities, and future projections in the energy utility industry. His comments in general complemented those of Mr. Falkenberry. He showed charts on the relationship of use to income in the users of the TVA. Growth by doubling in demand and supply each decade was illustrated. Differences in urban versus rural needs or demands were also shown with changes over time indicated. These are tools for forecasting in the TVA area. The objective is to meet the demands of users by providing flexibility in the system.

CODES AND STANDARDS

Charles T. Mahaffey
Assistant Section Chief
Building Research Division
National Bureau of Standards

Mr. Mahaffey discussed standards, specifications, and building codes in the housing industry. His presentation concentrated on the activities and experience of the National Bureau of Standards. A review on the definition of standards versus building codes was given. Two ingredients were cited in the construction of a standard: (1) description of the item of concern and (2) the tacit agreement associated with the standard. The agreement implied in any standard refers to concensus of the group preparing the standard. The extent of such concensus is not defined and cannot be evaluated. On the other hand, building codes are regulations pertaining to health, safety, and welfare. The latter is hard to define. Building codes are prepared or result after the fact has taken place. They are enforceable by Article 10 of the constitution. Reinforcing the regulations of building codes is the responsibility of the states and not the Federal Government.

A discussion on the inadequacy of building codes as applied to industrialized housing was presented. Mr. Mahaffey believes that local codes are unsatisfactory. They hinder innovations and new technology in the housing field. He cited that the John Manville industrialized housing project folded because of the red tape and restrictions they faced with local building codes. The need for a new code system in the United States was expressed.

The charge in present building codes is directed toward the performance concept. The National Conference of States on Building Codes and Standards (NCSBCS) is working toward establishing a Bureau of Accreditation Programs. These programs are intended to evaluate the whole housing system with the help of NBS. They will include quality and reliability evaluations. Individual states will provide the system with accreditations and the NBS will set the measurement techniques. The building code for New York State was cited as an early development in the performance code system. Localities must accept the entire system with no modifications so that no local provisions will be included. This code is divided into criteria for the various building types, such as single dwelling units and high-rise buildings. Mr. Mahaffey expressed his belief that if performance criteria are adopted, the building industry will introduce innovations on a large scale and will improve the industrialized housing market to meet the demand for housing and at a profit to the producer. However, the performance criteria will not necessarily result in lower costs for the consumer.

THE GENERAL ELECTRIC MODULAR HOUSING PROGRAM

Otto Klima
Vice President
Reentry andEnvironmental Systems Division
General Electric Company
Philadelphia, Pennsylvania

General Electric (GE) was first in the reentry business and other space applications. Mr. Parker predicted a surplus of engineers in the aerospace industry. GE then wanted to look at what to do with their surplus engineers. A plan was made to satisfy the needs of the 1970's.

After this introduction, Dr. Klima made a presentation of the housing program at GE.

GE bid on the military housing program at George Air Force Base (1967). GE won the first phase bid and was awarded the second phase. There were two bidders.

GE made a study of user needs which is available. GE built 200 houses at GAFB; these were completed by July 1971. J. C. Penny produced furnishings for \$4500 per house. The houses went from 240 manhours to 18 manhours for field finishing. Tolerances are held to 0.25 inch. The plant, located in Apple Valley, California, employs 130 people which produces two houses per day. Production uses a cast plaster method for walls, and the unskilled labor is \$3.00/hr.

The hours per house dropped from 3300 to 400 for 180 houses and work was transferred from the field to the factory.

GE-contributed value to the house is 9 percent in products; total GE value is 40 percent.

GE also has a facility at King of Prussia, Pa., which turns out cast plaster walls at 30 ft/min. This wall can have the texture of wood or brick. Cost is less than gypsum board wall by 15 percent.

HUD is having states accept industrialized housing; i.e., the code problem is known.

GE now has housing cost at \$8.00/ft^2 and thinks it will go to \$6.00/ft^2 FOB. Half the cost is in the property.

GE writes manuals for the site elector and the user. The people who live in the house should be able to maintain it.

GE is putting up relocatable houses at Norton AFB. Stressed skin floors are in use.

GE is helping the small-site erector with the management of their modules.

Fifty percent of the housing market is government subsidized.

GE went through an analysis of the whole system.

GE is to remain in business producing modules; it is not going into land development or new towns.

FORUM ON HOUSING

The Hon. John J. Sparkman
U. S. Senator (Alabama)

The 2-hour question-and-answer session with Senator Sparkman was interesting in the breadth of knowledge the senator has accumulated during 35 years in Congress and refreshing in his willingness to admit "I don't know" to several questions.

The following is a representation of several of Senator Sparkman's comments in answer to the many questions asked of him.

The policy of using housing to balance the economy is not a good one. ".....housing should not be rationed." The 1968 Housing Act spelled out the need for 26 million housing units by 1978. However, the schedule on which this number is to be provided is not rigid. The problem in the housing industry is that housing is provided on a retail rather than a wholesale basis. The new ideas in industrialized housing are worth studying. The response of the Homex Corporation in providing factory-built housing for the tornado-devastated people of Corinth, Mississippi, was most impressive.

The funding for Project Breakthrough was not special but was an experimental project of Secretary Romney. More of these type projects are feasible and funding for these projects would be favorably looked upon by the Congress. Research in housing should be encouraged and support for it may be forthcoming from Congress.

The new-town concept is appealing but the big problem is arranging for a large enough parcel of land for town development. The government, while it will not engage in the development of a new town, will make available its programs in other areas as well as providing incentives for the location of industry.

It should be remembered that people living in rural areas have housing problems as bad or worse than urban dwellers. There are federal programs geared to the needs of both groups. The major problems in the provision of rural housing are as follows:

1. Lack of ready credit availability.

2. Sparse market (individual houses are relatively far apart).

3. Lack of jobs, particularly industrial.

4. Lack of necessary public services.

Some of the most serious problems with regard to housing in general are as follows:

1. Codes — Many codes which are often in conflict.

2. Zoning.

3. Cost of materials and labor are high.

4. Land cost is very high.

5. Discouraging and expensive practice of charging points on home loans by the lending institutions.

THE WATTS PROBLEM

Eugene Brooks and Issac Adams
Watts Urban Workshop
Los Angeles, California

Mr. Brooks and Mr. Adams discussed the many problems that confront the various isolated minority groups in America. In and around the Watts area in Los Angeles, much despair and unemployment exists. Even though there is a "cotton curtain" of industry to the east of Watts, the Blacks represent only approximately two percent of those employed in these industries. For reasons of lack of skill, education, training, or unjust discrimination, the Black and other minorities do not find ready access to the available jobs.

Mr. Adams did not present a formal talk but supported the presentation by Mr. Brooks. Primary comments were concerned with the possibility of creating a community for low-income people. Drew Medical School has established a department of community medicine to study low-income

community medical needs. There is a dishomogeniety in the Black community. There are graduations of income and life styles. There is no such thing as a Black culture, since minorities have tended to pattern majorities in their life style. This effect may be reduced by recent attention to Black Consciousness and the effect of education.

Decisionmaking processes are as follows:

1. Intelligence.

2. Analysis.

3. Evaluation.

4. Normative system (values).

5. Decision.

This system breaks down at step 4 unless the decisionmaker can relate to those for whom the decision is made. Values are the products of various cultures, and a planner may be planning for a group he does not belong to and, therefore, fails to understand the problems of that culture.

APPENDIX B.

NEW TOWNS

New towns were an alternative for study by the Auburn Design Group. This appendix discusses new towns.

Page Intentionally Left Blank

APPENDIX B. NEW TOWNS

Historical Overview

Concerted programs for new town construction are fairly recent, although new towns have been built for hundreds of years. One of the most important historical occurrances in this respect was a set of ordinances proclaimed in 1573 by Philip II of Spain and called the "Laws of the Indies." This document, which was followed almost without exception throughout Spanish possessions, contained about 40 specifications and admonitions dealing with the selection of site, location of plazas and streets, and character of public buildings and private dwellings [B-1] . These laws are the principal reason why many Latin American cities are quite similar in layout, and quite different from Anglo-American cities.

In 1484, Leonardo da Vinci proposed that 10 satellite cities of 30 000 population each be built around Milan as a solution to the overcrowding which brought on the Black Plague. In 1898, Aarao Reis designed Belo Horizonte as a provincial capital in Brazil. It consisted of a geometrical pattern of radial streets and ring boulevards superimposed on a gridiron plan [B-1]. In 1956, the site for a new national capital, Brazilia, was selected far in the interior. The intention was to open up the vast Brazilian interior, as well as to provide a new national capital.

Venezuela is also building a large metropolis, Ciudad Guayana, as an effort to stimulate the national economy.

Probably, Venezuela's most important type of deliberate community has been the Garden City, originated by Ebenezer Howard in 1898. The garden city, according to Howard, is a compact, rigorously confined urban grouping. It is not a suburb, but the antithesis of a suburb; not a more rural retreat but a more integrated foundation for an effective urban life [B-2] . In Howard's city design, the central few acres contained civic and commercial buildings, with stores and shops nearby. Around them in a circle are houses and scattered churches, schools, and small parks. Factories are contained in an outer circle, and surrounding the area is a large greenbelt area. Beyond this is an agricultural area which is not part of the community. The greenbelt is intended for recreation and elbow room, and serves as a buffer against external urban sprawl. It also prevents the garden city from growing larger than originally planned.

Howard's garden city is a self-sufficient town with a population of about 30 000. The land is not owned by individuals, but by a limited dividend company; thus, there is no land speculation. Garden cities eliminate commuting through balanced employment.

The first garden city, Letchworth, was begun in 1903, followed by Welwyn in 1920. Howard personally founded, helped govern, and lived in both cities... Today these prototype garden cities are stable, successful communities [B-1] . Howard's efforts were directed at substituting what he felt to be organized, rational land-use for the ills of irrational land-use in the older cities and clean, fresh air for the befouled vapors of the older towns.

The garden city idea was expanded into the new towns movement in the 1940's. The enabling legislation was the Distribution of Industries Act (1945), the New Towns Act (1946), and the Town Development Act (1952). These acts called for the construction of 15 new garden cities of 25 000 to 60 000 people (eight near London as part of the decentralization plan for greater London) and for controlled expansion of many existing towns [B-1] . The designs of the towns were similar, although there was no conscious plan of coordination.

The neighborhood, two-story housing, gross town density of 10 to 16 persons per acre with a net residential density of 40 to 60 persons per acre formed the pattern. Industry was located in one, two, or three separate zones, while the neighborhoods circled the town centres [B-3].

Such a national policy of building, within a few years, with complete new towns designed to deal with a variety of urban and national problems (e.g., population pressure in the metropolis upgrading of living standards, irrational growth patterns) is unique in human history. No plan of such a scale has been attempted before or since. Although it is too early to judge conclusively, the plan is regarded as successful in several ways. The towns are recognized to be economically sound, income, are exceeding expenditures [B-3] , London has been thinned out, and a greenbelt surrounds the city [B-1].

Potential Value for Regional Planning

The Greater London Plan. The Greater London Plan, a part of the British New Towns plan, provides an example of the possibilities of new towns for regional planning and the control of population distribution.

The Greater London Plan had a dual objective: relieving overcrowding in metropolitan areas and creating new garden cities. These goals were to be accomplished by encouraging people, industries, and businesses to move 25 to 30 miles from Central London. The plan, designed to rebuild war-torn London, reduce its population, create a greenbelt around the metropolis, and dispense industry [B-1], has been described by an American sociologist as probably the most comprehensive, realistic and daring adventure in city planning [B-4].

The aims of the Greater London Plan are to discourage further population and industrial growth, and to provide better distribution of existing industry and housing.

> "The region is divided into four rings: The inner country..., a suburban ring in which density declines from 75 to 50 people per acre with inreasing distance from the City Center, a recreational greenbelt with a nominal density of zero, and a country ring of agricultural land through which are distributed eight new satellite plans of approximately 50 000 population each. Businesses and industries moving out from the Central City are encouraged to settle in these new towns, which are not intended for commuters [B-1]."

The plan controls the growth of the metropolitan region by setting limits on the permissible density in each band, by the limiting power of the greenbelt, and by providing sites for factories in the new towns beyond the greenbelt.

No such comprehensive plan is possible in the United States at the present. There is no governmental unit with authority over community and land development and planning.

Land-Use Planning. Land-use planning is an extremely inclusive area. A moments thought will show the range of things involved in all the uses of land, such as housing, business, industry, agriculture, and highways. Thus, planning all uses of land would require control over all its uses. The Greater London Plan was possible because the British Government is given a much greater degree of control over the uses of land than is the American. The United States attempted, during the Roosevelt era, to make a start in this direction by building three new towns named Greenbelt, Greenhills, and

Greenbrook. This operation stimulated much opposition from the building and real-estate industries, and the towns were eventually turned over to private developers. Most discussion of land-use planning in the United States centers around schemes for providing financial or other incentives for people to use land in some desired way.

The potential of the government for land-use influence is large, but until now, its exercise has been haphazard and often contradictory when it is used. Communities are often transformed, both in size and character, by the decision to locate a military or governmental installation, yet the government seldom seems to consider the land-use impact of its decisions. Thus, our towns and cities have grown up haphazardly, with little thought being given to the total effect. Unplanned growth and development are perhaps acceptable under conditions of abundant space and natural resources, but population has a way of growing, resources are not infinite, and land is a limited facility.

The urban population is increasing at the rate of about 3 million per year. This increase calls for about 1 million acres of land development per year [B-5]. The figure currently before Congress is that about 28 million new housing units will be required in the next decade.

If this growth is not channeled in some way, it will contribute to further urban and suburban sprawl to the further decay of the inner cities, to pollution, and to destructive land use.

A more rational alternative would be to organize this growth into new towns and planned communities. Although new town construction presents many problems, such towns are an attractive alternative to uncontrolled growth.

New towns, properly planned, could conceivably accomplish some or all of the following goals:

1. Relieve some of the population pressure on the large cities.

2. Allow for land-use planning with an eye to the preservation of open space and the conservation of resources.

3. Permit innovative building systems to be tried on a large scale.

4. Demonstrate the economic feasibility of large-scale and long-range planning to financial interests.

5. Show that human needs and human development can be planned for in a more rational way.

Potential Value for Social Experimentation

Total Systems Experimentation. Participants in the Minnesota experimental city program have concluded that it is virtually impossible to apply new and developing technology in existing urban settings, because of the investment required, the resistance to change, and the required destruction of existing facilities, which preclude the probability that available and future technological and social advances could be applied on a large scale in existing urban environments. However, real progress could be made in a new city created for experimental purposes [B-6]. The report concludes that social innovations face much the same problems as physical ones in existing cities.

In contrast, the new town provides a laboratory for total systems experiments, in which the values of virtually all variables can be controlled.

Some possible areas for experimentation are discussed in the following sections.

Socioeconomic Mix. There seems to be fairly wide-spread agreement about the need for avoiding segregation in communities. (The term "segregation" is used to refer to spatial separation on the basis of any characteristic; e.g., race, occupation, or social class.) The reasons for regarding segregation as undesirable derive from a cyclical set of events, the results of which are becoming apparent in our cities. In outline, the cycle proceeds as follows:

1. Communities typically evolve in the direction of neighborhood segregation on the basis of occupation, prestige level, income, or race. This occurance seems to be inherent in the dynamics of city growth.

2. Residential segregation may lead to social isolation, a condition in which the individual has little contact with, or knowledge of, conditions outside his neighborhood or community and tends to view his community as coextensive with the world.

3. Isolation leads to an essentially one-sided, incomplete view of the composition and workings of the total society. The common picture of the cosmopolitan, urban city dweller is grossly atypical. In the large cities, the central city slum dweller is essentially a resident of a block or a small

number of blocks, rather than of the city as a whole. He has little or no knowledge of the city outside his own neighborhood. The same can be said of the suburbanite.

4. Isolation tends to contribute to interclass and race misunderstanding and hostility. This is apparent in the rhetorical exchanges between black militants and whites in the continuing degrading restrictions placed on welfare recipients and in the recurrent notes of social Darwinism sounded in legislatures across the nation.

5. Class and race hostilities contribute to the perpetuation of segregation and isolation and to the perpetuation of low-income life styles and attitudes. This leads to further expressions of hostility, including violence and rioting, which hasten the physical decay of the central cities and broaden the hostility of the working and middle classes toward the poor and the Black.

To avoid this cycle in new town construction, neighborhood integration seems to be imperative. The vicious cycle of the perpetuation of low-income life styles and attitudes (and middle-class provincialism) can perhaps be interrupted through small town designs which throw together people from variety of class and ethnic backgrounds. However, this problem is far from simple. It has been pointed out that social stratification has led to geographic separation, and this in turn has accentuated social stratification, and perpetuated class division, and it is unrealistic to assume that these class divisions can be overcome merely by reducing the physical distance between classes. It is also highly improbable that the different classes would use the same social institutions. All that would be acheived is the present pattern of social and geographic differentiation on a smaller scale [B-7].

There are also those who argue that since communities tend to separate naturally on the basis of similarity, conflict will result from any attempt at integration. Community residents often resent and resist the mixing of different occupational and income levels in their neighborhoods. Studies have shown that homogenity produces more congeniality (2. above) and that conflict arises between people of different backgrounds (3. above). Perhaps if a balanced neighborhood were created, people would separate themselves within it [B-8].

Despite these considerations, most new-town planners favor neighborhood and community heterogeneity, and several reasons are given for this. One is that children tend to learn better in heterogeneous classes.

Another is the "role model" argument which holds that contact with the more well-to-do classes can motivate the poor toward upward mobility. Segregation of neighborhoods is often taken as evidence that efforts toward self-improvement are futile [B-8]. The elimination of a culture of poverty may require the elimination of neighborhood homogeneity.

Planners of new towns have generally opted for socially balanced communities, usually without specifying exactly what a balance consists of. The new town of Tapiolo, Finland, received inhabitants from different walks of life; therefore, it was realized from the beginning that various adjustment difficulties might occur [B-9]. The new town of Jonathan, Minnesota, will be divided into several villages each of which is conceived as a community of approximately 7000 persons housed in a variety of units covering all price ranges and including most density types [B-10]. The town of Columbia, Maryland, seems to have been designed with a similar plan in mind.

However, these examples are highly selective. New towns have been designed for a great variety of reasons, many having nothing to do with an optimum socioeconomic mix.

A UNESCO publication [B-7] reports about 200 new towns built between 1940 and 1960. Purposes for building were the creation of capital cities, strategic or military reasons, relieving central city congestion, and escape from population pressure [B-1].

Many community developments in the United States deliberately create social-class segregation. The town of Clear Lake, Texas, is a good example of this. The community is divided into three geographically separate subdivisions consisting of houses at three price levels. This town is perpetuating the social-class segregation and isolation discussed above.

In summary, there is no hard answer to the question of the optimum socioeconomic mix. Most planners regard the inclusion of a socioeconomic and racial cross section of the population as desirable, and advocate the use of various kinds of economic and social inducements to motivate people to live in such a community. Some such inducements would be government-subsidized home ownership, location near place of work, recreational opportunities, and perhaps the desire on the part of some to take part in a social experiment and to live in a totally new community.

The proportions of low-, middle-, and upper-income housing in a community will almost inevitably be arbitrary, but will depend to some extent on the financial structure of the project, and to perhaps a greater extent on the ideology of the planners.

Type of Ownership. Two types of questions exist here: (1) Who owns the development corporation which acquires the land and executes the town design (e.g., one individual, a partnership, a publicity owned corporation, or a government) and (2) what form of tenancy arrangements are made with the individual residents of the town: rental, leasing, private ownership, or co-op ownership.

Joseph Intermaggio, in a talk given to the Auburn Design Group on June 17, 1971, talked about some of the problems the initial owner of Reston encountered in trying to develop the town on his own. He became overextended and finally had to sell controlling interest to Gulf Oil Company. Columbia, Maryland, has had public financial participation from the beginning. To date, there has been very little governmental financial participation in new towns in the United States. This is in contrast to European countries where most new-town construction is governmentally financed. But it is on economics alone rather than through altruism that new towns will or will not succeed in this country [B-5].

If new towns are required to show a profit, there is the danger that sociological and ecological considerations may be compromised in the service of this need; and the further danger that regional coordination in terms of location, adaptability to change, and the needs of the low-income population will not be forthcoming. The latter may be seen in the finding of a survey of 28 new towns that only 19 percent provided housing for family income levels below $ 5000 per year, while about 35 percent of the families in the United States earn below $ 5000 per year [B-5].

In terms of individual tenancy, an overwhelming argument does not appear for any particular form, although some form of individual ownership or investment seems desirable.

It seems apparent that the conditions under which housing is acquired is at least as important as the housing itself. Housing in which people have no personal stake is often ill-treated and vandalized. This is compounded in projects such as Pruitt-Igoe by the concentration of thousands of poor, often unemployed Blacks in the same small area, in effect creating an instant ghetto.

The HUD 235 Program seems to be based on an assumption about the value of ownership in motivating people to maintain the property in an acceptable way. No hard evidence exists contrary to this assumption, but it seems likely that the desire for home ownership is coupled with the desire to maintain

the home in an acceptable way. If this is the case, then ownership is not as great a motivating force as might be assumed.

One interesting form of ownership can be found in Tapiolo, Finland, where the apartment owners in a multistory building are stockholders in a joint stock housing company that is managed by a board appointed by the occupants at the annual company meetings [B-9]. The interesting aspect of this form of ownership is that it involves a share in the total community, and so presumably may lead to interest in the affairs of the whole community rather than the individual's isolated part of it. This form of ownership seems particularly interesting for this reason. Involvement in the total community could prove to be one way of breaking down racial and social class segregation. If all are equal in their status as citizens and partowners of the community, other differences may come to seem less important.

Size and Location. Since the size of a community is to a great extent a function of its location, these are considered together. New towns range in size from a million or so in the case of Brasilia to a planned 50 000 in Jonathan New Town. The planned sizes are a function of the location and of the purposes the towns are expected to accomplish. The towns under the domain of the London County Council, for example, are designed to alleviate population pressure in central London and to channel industrial development. Brasilia was created for the purpose of opening up the vast Brazilian interior and was planned as the national capital.

The point being made is simply that no statement about optimum size can be made without knowledge of the location, and both size and location depend on the intended purpose. If the goal is to create some of the amenities of small-town life in an urban setting, obviously, the size limit will be toward the lower end of the scale.

Ideally, new town plans should be integrated into regional developmental land-use plans. In this case, the size and location of the towns would be determined by a combination of variables such as population-growth projections for the region as a whole, and for cities within the region; the need to alleviate congestion in the central cities; the economic needs of the region; the judgements about the human benefits to be derived from various size ranges and socioeconomic mixes. One possible plan would provide towns under 100 000 ringing the larger cities in each region, close enough for reasonably quick access but far enough to avoid being swallowed in city expansion, and protected by low-density belt. This, of course, is based on the London County Council Plan, and would require a regional planning authority. To date, the closest we

come to this in the United States is the Metropolitan Council of the Minneapolis-St. Paul area which influences planning in the area through its control over metropolitan utilities, transportation planning, and open-space policy.

The Paired City Concept. One approach to new-town thinking that is currently being put forth, which many feel will cause supportive rather than competitive interaction between new towns and existing urban centers, is the new-town-in-town concept. One version of it is called paired communities or tandem development.

An example of this notion was proposed for the Detroit area and discussed in the June 1971, AIA Journal article entitled "City and Suburb in Tandem." Detroit, it should be noted, is suffering so badly from an exodus of people, commerce, and industry to the suburbs that at a recent Press Club Banquet a banner read "will the last company to leave Detroit please turn off the lights." A pairing of a new-town-in-town with a new-town-out-of-town for Detroit is seen as a way to ensure that future urban growth, both physical and economic, will consider the needs of both city and suburb so that one is not expanded or enhanced at the expense of the other. Essentially, this concept implies the planning and construction of one new town on two sites. It is based upon the following principles:

1. Paired new-town communities, one within center-city Detroit and one located in the suburban fringes. Both would be developed simultaneously under a single developmental authority. Nine or ten potential pairs were identified in the Detroit area.

2. Each pair is geographically separated by 20 to 40 miles but exists together as a political, social, and economic entity.

3. Each member of the pair is linked with the other by mass transit lines and other services in common.

4. Housing for every income level will be provided in both elements of the pair.

5. Development of common land is to be undertaken between and for residents of both communities so that the suburban and city dweller can and will share the entire region equally and equitably.

6. The Detroit in-town sites include 600 to 2000 acres for 25 000 people (approximately 25 per acre).

7. Both components will be built at the same time, under one plan, and with one administration.

8. There will be a variety of vital links with each other, generating benefits for both.

9. The out-of-town component includes a trio of villages clustered in a town setting with shopping, office, manufacturing, government, and other major facilities.

10. The in-town component will include theatres, research and medical centers, large libraries, and other things the true urbanite holds dear, but which many new towns cannot afford.

11. In-and-out-towners are inhabitants of the same community and share the same school system, service facilities, etc. They are also seen as sharing the same desire for a good and meaningful life.

12. A variety of industry and service oriented jobs will be available to all. In fact, building of the in-town component with its provision for industrially produced housing is envisioned as source of employment.

13. Social objectives of both components emphasize achievement of a life style, enabling residents to realize full expression of their own individuality together with development of a sense of community based on as widely diversified an economic, educational, racial, and age group population as possible.

14. Government linkage of the kind envisioned offers opportunity to deal not only with physical, economic, and social problems of the metropolis, but also to demonstrate that better approaches to local government are possible as well. The governing structure will:

a. Be created by a special district brought about by state legislation along with a matching special service district.

b. Supplement existing government structures.

c. Provide this service district as a legitimate vehicle for early and continuous citizen participation in all phases of civic governance.

The State of Michigan will be encouraged to channel future industrial growth and housing construction into the paired new towns, thereby preventing additional sprawl in Detroit. In this way, existing open space can be better preserved (an "old" new-town goal).

15. Projections of the Detroit paired-town economic model by the RER Corporation include a 20-year development span requiring $ 1 billion outlay ($ 160 million land acquisition and development, $ 639 million for housing, commercial, industrial structures, and $ 254 million for service facilities).

a. Expenditures are projected as exceeding income by 2.4 percent or $ 26 million, requiring public subsidy of a little more than $ 1 million per year for the development period.

b. On the other hand, alternative projections for income indicate that an excess over expenditures by $ 25 million is possible (once again, we are confronted with the vagueness of planning projections).

c. If social objectives are taken into account, arguments for project support are most persuasive even at maximum support levels.

16. The paired town will provide two new job sources with easy access to the new jobs by the entire community.

By way of obvious criticism, these initial studies fail to indicate any clear means of implementation — Detroit leaders will have come to grips with this question. Other similar plans, such as those by the Greater Hartford Corporation that is composed of 20 leading companies in Hartford and the surrounding area, stress similar values. The Greater Hartford Process is seen not as a study but a continuous process of community development. It envisions, once again, new-town creation within older areas of the city tied to development in the outskirts or in heretofore undeveloped parts of the region. This will, it is felt, help to contain the urban sprawl kind of unplanned development that is so common around our cities. Paired towns could stimulate national as well as a region-wide effort to awaken new socioeconomic values, match development with opportunities, provide a workable framework for investors, and bring new and supportive living environments into existance.

<u>Governance.</u> The governance of a new town can present some problems that are subtle and different from those of an old city. First, the plan of the new town needs to be approved by, and implemented in accordance with, some existing political institution. For instance, Reston is organized under Fairfax

County, Virginia, while Jonathan is primarily under the jurisdiction of the City of Chaska, Minnesota. In both cases, the new town (a large one) will grow up under a rural government jurisdiction. County governments are traditionally rural oriented. The City of Chaska has a population of about 4000, while the planned size of Jonathan is about 50 000. There is not sufficient experience yet to indicate what problems or conflicts of interests will arise as the new town approaches its ultimate size. A second potential problem relates to the intracity governance during the transient period. Clearly, one would like the new town residents to have a voice in at least selected areas of the new town policies, but there may be a set of interest conflicts here between resident objectives and developer objectives. Indeed, it should not be expected that the short-term objectives of these two groups should coincide. Again, there is not sufficient experience available to be able to point to specific problems or to the resolution of such conflicts.

Conclusions

It should be acknowledged that many people who are experienced in planning and development continue to be pessimistic regarding the promise of new towns in America. While acknowledging the degree of success new towns have achieved in Europe, they continue to hold little hope for their successful implementation in this country on anything other than a very minor scale. These critics point to numerous economic, social, and political factors as constraints upon the process, which will allow only what are, in effect, the suburban communities of the "bedroom" variety. Up to this point, their cynicism has been largely well founded. Overlaid upon all of this is the belief by many that the new-towns concept is a smoke screen for continued wholesale conversion of valuable open land and other natural resources into still more suburbia at the expense of existing urban centers.

While these criticisms may be legitimate in terms of many current developments masquerading as new towns, it scarcely justifies total rejection of what may be one viable solution to some of the many problems of our growing urban society.

Obviously, many of the foregoing considerations and component elements of new-town thinking are mutually exclusive. The problem becomes one of developing, implementing, operating, and monitoring control and organizational mechanisms that will enhance flexibility and provide a maximum number of alternatives while minimizing the potentially negative effects of free growth or of individual excesses. At the same time, predictable, ordered growth

and development must be provided as it is a prerequisite to any serious economic venture. The sum total of these objectives is quite staggering. They may in fact be impossible in light of the kinds of tradeoffs required. Determining the proper level and scale at which control must operate and establishing the requisite amount and kind of communication between participants are required to successfully establish a sufficient degree of sensitivity in control. Thus, whether we call this thing we have yet to devise a "matrix" or an "urban infrastructure," pursuit of its development is essential if the promise of new towns as currently conceived is to be achieved.

REFERENCES

B- 1. Thomlinson, Ralph: Urban Structure. New York, Random House, 1969, pp. 212-213, 217, 264-266.

B- 2. Howard, Ebenezer: Garden Cities of Tomorrow. Lord, Faber and Faber, 1902, MIT Press, 1965.

B- 3. Taylor, Gerald Brooke: Social Problems of New Towns. Community Organization in Great Britian by Peter Kuenstler, New York, Association Press, 1961, pp. 61-62.

B- 4. Hallenbeck, Wilbur, C.: American Urban Communities. New York, Harper, 1951, p. 553.

B- 5. Dames, Thomas A., and Grecco, William L.: A Survey of New Town Planning Considerations. Traffic Quarterly, XXII no. 4, October 1968, pp. 555-570.

B- 6. The Minnesota Experimental City Progress Report. Minneapolis, 1970, pp. 16-17.

B- 7. Viet, Jean: New Towns. UNESCO Reports and Papers in the Social Sciences, no. 12, Paris, UNESCO, 1960, p. 48.

B- 8. Schorr, Alvin L.: Slums and Social Insecurity. U.S. Department of HEW, Social Security Administration, Division of Research and Statistics, Research Report no. 1, pp. 48, 50.

B- 9. Hertzen, Heikki V.: Practical Problems of New Town Development. New Towns Seminar, Working Session III, Tapiolo, August 13, 1965, pp. 3-4.

B-10. Jonathan New Town: Design and Development. Jonathan Development Corporation, 1971, p. 30.

APPENDIX C.

COMMENTS ON SOCIAL AND ECONOMIC MODELS

Social and economic models were an alternative for study by the Auburn Design Group. This appendix discusses social and economic models.

APPENDIX C. COMMENTS ON SOCIAL AND ECONOMIC MODELS

Introduction

This appendix reviews some of the contributions to the modeling of social and economic systems that have been made.

Activity in the development of quantitative social and economic models was noticeably lacking before 1960. A few efforts of modeling the economic development of specific geographic areas were begun during the early 1960's and the activity increased during the latter part of that decade. The development of economic and population models outnumbers the efforts at modeling other aspects of the social system, although contributions have been made in other areas. Specifically, a model to be used for highway and rapid transit planning was developed by 1965 [C-1]. In 1970 [C-2], a book describing a model of general urban dynamics was published and, in 1971, a report [C-3] describing a model of household formation appeared.

It appears that interest in the modeling of social and economic systems is increasing among the scientific community and that there may be rapid development of this area during the 1970's.

A brief review of some of the models already developed is discussed in the following sections.

Economic Base Models

A number of models which have been developed can be classified as economic base models [C-4 through C-9]. These models attempt to predict the economic activity and population increases that may occur in specific geographic areas. The number of geographical subdivisions which are made within each general area and the time span over which the predictions are attempted vary with each model. These economic base models do not attempt to simulate a wide range of conditions.

Another model, the Bay Area Simulation Study (BASS) [C-10] is an extension of the economic base model. In addition to the simulation of industry and population growth, the BASS report includes predictions of land use for the San Francisco Bay Area.

A major difficulty which the developers of the previously mentioned models encountered was a data base. Often, the economic or population information which the investigators considered necessary was not available. In addition, the reliability of some data was questionable. The availability of a sufficient and reliable data base is a very real problem when dealing with models that are built for specific geographical areas.

A further problem with these models seems to be the lack of coordination between the various areas of the country. This can easily be seen by noting the titles of the eight reports. An additional problem is that of follow-up of the predictions and a continual updating of the models developed. These aspects may be available; however, their source is unknown to this author.

To summarize, economic base models have been developed for specific areas of the United States and these models attempt predictions of the industrial and population growths over various time periods. The models often suffer incomplete or unreliable data bases and a management procedure which would continually update the model and its data base.

Element-Oriented Models

In contrast with the economic base models that were discussed in the previous section, several efforts at constructing more generalized models exist. These models are more general in the sense that they may be applied to any geographic area, but more specific in the sense that they apply to only a specific problem; e.g., transportation or household formation.

As one example of these models, the gravity model [C-1] can be used by any urban area for transportation planning. In the opinion of this author, the more general approach to a specific problem which is done in the gravity model is an approach that is preferable to the approach exemplified by the economic-based models for specific geographic areas.

The HOPS model [C-3] was to provide a detailed simulation of the characteristics of future individual household populations in the United States on a yearly basis. This model could be applied to any specific region if the initial conditions and the growth parameters are known for that region.

In summary, the gravity and HOPS models apply only to the simulation of specific elements in the social system but which can be applied to any geographic area.

Policy Models

A third type of model is that presented in Reference C-2. The type of model conceived by Forrester differs in several respects from the economic-base or element-oriented model previously mentioned. The model developed by Forrester could be applied to any geographic area which is a city, but does not treat any specific problem. The model instead treats the city as a system and attempts to simulate the growth, aging, and decline of urban areas. Forrester attempts to answer questions concerning the desirability of governmental programs (e.g., low-income housing or job training) by introducing these programs into the urban model. Since this model and the results which Forrester derives appear to be raising considerable controversy, it may be well to review them here.

To determine the desirability of various urban revitalization programs, Forrester applied, as inputs to the model, the various programs that have been proposed and used in some instances in an effort to revitalize urban areas. The effects of almost all most-used remedies are either mixed, with small changes taking place, or entirely negative in their result.

A job program for the unemployed at the rate of 10 percent per year for 50 years had an almost entirely unfavorable result. This occurred primarily because the job program attracted more underemployed people to the city. An important point to be made here is the importance of secondary effects on the programs. The job program would perhaps be successful if the migration of the underemployed to the cities could be prevented, which is not possible politically.

A job training program for the underemployed is also a possibility and was simulated by Forrester. The results of this simulation indicated that the service of this program to the individuals involved was positive, but its usefulness to the city as a whole was less clear. In addition, another important general point is made. Although an expected total of 19 600 people per year were to move from the underemployed to the labor class, only 11 300 actually did so when the program was simulated. This reduction occurred as a consequence of the relaxation of the internal processes which normally provide for underemployed mobility. As a result, the efficiency of a job training program may be considerably lower than expected, and therefore more costly. The relaxation of the normal internal mechanism for change when the external input is provided is the important point.

Direct financial aid to the cities is also simulated. This procedure did nothing to help the city, and, in fact, caused an 8-percent increase in the tax ratio needed from within the city as a result of the increase in attractiveness of the city to the underemployed. This is an example similar to the first case of a job program, where secondary effects negate what would appear on the surface to be a positive program.

Low-cost housing construction as simulated in the model proved to be much more detrimental in the long run than any previously discussed program. Slum demolition and construction of low-cost housing at the rate of 5 percent per year had the simulated effects of attracting people from the underemployed category to the area and fostering a higher land-occupancy ratio. Furthermore, an unfavorable population ratio and rising tax rate discourages the type of new construction which the city needs most — new industry. Again, a major secondary influence has been overlooked.

Do any programs show favorable influences? Yes, new enterprise construction produces favorable changes in general, but is not the direct action type of program which can be carried out by a city. Declining of demolition industry is an action program of mixed merit. The demolition slum housing program appears to be the most beneficial in the long run. This program allows the clearing of land for the building of new enterprise. Surprisingly, a restriction in worker-housing construction coupled with demolition of slum housing produces the most beneficial effects. The demolition of slum housing has the effect of decreasing the migration of the underemployed to the city because of reduced attractiveness and of increasing the job opportunities in the city. Restricting worker-housing construction also provides more land for new enterprise construction.

In summary, the urban model advanced by Forrester provides a convenient mechanism for testing the various urban revival programs. Even though the numbers many not be exact, the trends indicate what may be expected, and several important insights can be made concerning the effectiveness of urban renewal programs. First, secondary effects may negate a program which would initially appear beneficial. Second, the efficiency of programs may be considerably lower than expected because of the relaxation of the normal internal mechanisms. Third, lasting beneficial results are indicated by the model from the application of a combination of several programs. Some of the programs which show the most promise for revival of the city may not be the most popular politically.

If the city is to survive, the selection of programs for the revival of the city must be done by considering more than first-order, politically popular measures. The type models presented by Forrester or other types must be used to examine the effects of proposed changes in programs and policies. The planners of new cities, in particular, should be aware of urban dynamics and avoid the decay which normally takes place. New-city planners do not seem to be doing any planning in this area at present. The modeling of human behavior and urban dynamics is possible and shows promise for policy formulation and implementation. Since this is the first model of this general nature to appear, it will undoubtedly stir increasing controversy [C-11, C-12].

Conclusions

It should be emphasized again that the author does not consider the review of modeling as being complete. However, from the reports which have been available, general observations can be made as follows:

1. There has been little or no coordination in the economic model developments.

2. In general, no provision appears for updating the economic models developed.

3. All models often suffer from the lack of a sufficient and reliable data base.

4. The element-oriented models applicable to any geographical area appear to be more useful than models that apply only to a specific geographic area.

5. Policy models necessary for the simulation of urban and national dynamics should be developed.

REFERENCES

C- 1. Calibration and Testing a Gravity Model for Any Size Urban Area. U.S. Department of Commerce, Bureau of Public Roads, 1965.

C- 2. Forrester, J.W.: Urban Dynamics. The MIT Press, Cambridge Mass., 1969.

C- 3. Jennings, D.M.: The Household Prediction Simulation (HOPS). Stanford Research Institute, Menlo Park, April 1971.

C- 4. Henderson, J. M., and Krueger, A.O.: National Growth and Economic Change in the Upper Midwest. University of Minnesota Press, Minneapolis, 1965.

C- 5. The California Economy 1947-1980. Stanford Research Institute, Menlo Park, 1960.

C- 6. Future Development of the San Francisco Bay Area, 1960-2020. U. S. Department of Commerce, Business and Defense Services Administration, U.S. Government Printing Office, Washington, D.C., 1959.

C- 7. Berman, B.R., Chnitz, B., and Hoover, E.M.: Projection of a Metropolis. Havard University Press, Cambridge, 1961.

C- 8. Projective Economic Study of the Ohio River Basin, Appendix B. Ohio River Basin Comprehensive Study, U.S. Government Printing Office, Washington, D.C.

C- 9. Hoch, I.: Economic Activity Forecast. Final Report, 1959.

C-10. Jobs, People and Land, Bay Area Simulation Study (BASS). Special Report No. 6, The Center for Real Estate and Urban Economics, Institure of Urban and Regional Development, University of California Printing Department, Berkeley, 1968.

C-11. Hester, J., Jr.: A review of J.W. Forrester's Urban Dynamics Book in Science. vol. 68, May 1970.

C-12. Babcock, D.L.: Analysis and Improvement of a Dynamic Urban Model. Ph.D. Dissertation, University of California, Los Angeles, 1970.

APPENDIX D.

VARIABLE ALTERNATIVES MODEL

The variable alternatives model living unit was an alternative for study by the Auburn Design Group. This appendix discusses the variable alternatives model.

APPENDIX D. VARIABLE ALTERNATIVES MODEL

The concept of a variable alternatives model can be defined as a combination of processes, organizations, and hardware which together have the capability of producing a range of differing living units and living-unit aggregations. This is obviously a very general definition that does not contain many of the implications that one associates with that label. One needs to consider a strategy for realizing this concept as well as a strategy in terms of the properties of its hardware. The way in which one thinks about the strategy hardware might be analagous to componentized hi-fi systems. Many are familiar to some degree with the potential for assembling a series of electronic components into a subsystem and subsystems into stero systems.

Any strategy for realizing the concept at the living unit scale must include the following:

1. A planning function which can identify user requirements, identify and evaluate alternative physical solutions, and render the chosen solution into technical instructions.

2. A production function which can organize materials and labor to produce the hardware and assemble the hardware into products.

3. A technology which is physically able to make the range of products desired.

There are residential building strategies which realize the concept definition; e.g., the architect/contractor/stick technology combination. Anyone who questions the capability of this strategy to provide diversity need only review the architectural journals of the past 10 years to be convinced. The problems with this strategy are obvious. Together, they amount to an inefficient utilization of materials and manpower which results in costs that are greater than most consumers can pay. It may be observed that the technology used effectively by this strategy is not ineffective when applied in the developer-builder/stick technology strategy. The same diversity is not achieved because the developer-builder is minimizing the planning function and attempting to optimize the production function.

The strategy to be discussed has the following characteristics:

1. The planning function is accomplished by the use of predesigned partial solutions which are sorted and assembled with pattern books, or programmed design procedures (manual or automated) manipulated by consumers and/or professionals.

2. The production function is intensively industrialized (in-factory, rationalized procedures, mechanized, and automated) for parts, units, and assemblies. The final assembly of subsystems into a specific unit can be accomplished in factory, on site by a builder, or on site by a consumer.

3. The technology is an open-systems industrialized building system composed of parts, units, assemblies, and subsystems capable of being assembled into a wide range of different living units and living unit aggregations.

Derivation of the Strategy's Requirements

Product Range — Initial Fit. A very narrow range of products is on the market. More than 75 percent of recent production is single family. These units vary in size but are very similar in their other properties; e.g., spatial properties of volumetric subdivision, topological properties of unit configuration with respect to privacy, and alternatives for provision of usable private exterior space.

The more dense forms of housing, high- and low-rise apartments, townhouses, etc., exhibit even less variety. The poverty of alternatives goes further than physical alternatives; e.g., consider forms of tenure.

Previous comments have shown the need for variety based on a concept of a no-norm population. The following points may reinforce those discussions:

1. It is important to understand that most of the American population's aspirations have gone beyond simple physiological needs. Consider Conway's use of Moslow's model. The point is that "needs" can be and inevitably will be other than physiological. Freedom has always been considered a human need. Definition of freedom is continually changing. Could it mean self-actualization or maximum alternatives?

2. One way to think about the non-normative nature of our populations is to divide it by ages of household members, number of household members,

and composition by age and kinship relationship. After partitioning in that fashion one can go further and classify by income, cultural and ethnic values, objectives of the household, and objectives of individual household members. This simple exercise results in the realization that the number of different household need profiles may be only of a slightly lower order of magnitude than the actual number of households. However, the significant differences which may be capable of physical manifestation are considerably fewer.

On the basis of the above considerations, assume that the strategy must have a capability of making a large range of different specific products.

Flexibility — Adjustment in the Fit. User needs change through time as follows:

1. Physical changes in household composition, age, income, size, etc.

2. Changes in taste and aspirations (the design of public housing in this country has ignored these changes, resulting in many cases in failure of the housing).

Accomodating these changes may involve physical expansion, physical contraction, spatial change, changes in color, texture, etc. It can be argued that many such changes are possible in the conventional frame structure; however, the cost in effort and cash for most of these changes is too great for the average consumer.

With the above considerations in mind, the strategy must be capable of providing specific products which can be easily and economically changed.

Adaptability — Remaking the Fit. Housing is a necessity; as such, it has a necessary useful life. If the number of households equals or exceeds the number of units over a period of time, a specific unit will continue to be used until it becomes hazardous or is removed. The necessary useful life is therefore a function of the rate of removal. Our current total housing stock divided by the average rate of removal over the last decade will yield the approximate necessary useful life. Calculations for the last two decades and the 1970's indicate that we may expect units to be used on the average for 100 years [D-1].

Obviously, a unit will become obsolete long before its necessary useful life is complete, either from (1) physical deterioration of a part or all of the unit, or (2) general changes in taste or technology which result in changes in user expectations.

One objective of housing designers and producers should be to equate a unit's physical and cultural usefulness with its necessary useful life. Failure to do so will result in the continued use of units that are inadequate or dangerous or which are perceived by the users to be inadequate. At the current rate of replacement, a unit designed to last 30 years will be substandard housing for 70 years.

Two strategies for solving this problem are as follows:

1. Design units with short useful lives while manipulating the production and removal rates to achieve equal necessary useful life; in otherwords, disposable housing. The necessary useful life would have to be very short, with the physical properties of the unit designed to last only that long. The use of less durable materials might provide a savings in natural resources. This strategy would require complete control of production and supply by government.

2. Design a building system with functionally and physically separate subsystems such that there is a correlation between the ease and cost of replacing a subsystem and the expected rate of obsolescence.

It is assumed that approach can be provided by the strategy.

Benefits of Industrialization. The benefits of industrialization have been listed before; hence, they will simply be listed as a reminder:

1. Greater quality control.

2. More control of process; thus, weather protection, physical security, stable service, and rationalized procedures.

3. Less absolute use of labor through mechanization.

4. Little or no requirement for skilled labor.

Considerable debate concerning the potential cost reduction should result from the above features. The best estimates indicate a 10 percent savings in initial costs.

Capital Risk — The All-or-Nothing Syndrome. Capital risk in plant and machinery is great for producers of modular products. However, if the

systems are of the type generally described above, a company may engage in production of only one subsystem, and it then risks a good deal less; the risk is distributed over a number of specialized producers.

The open-systems approach to industrialization of buildings encourages greater competition in the industry. It will allow a business in a similar industry to enter the housing industry without producing and making an entire system. In the past, firms interested in getting into this new market have been forced to develop an entire system. Often, they have not been capable of doing this task well. Their resulting failures have greatly retarded the introduction of industrialization in this country.

Shipping. The modular procedures have incurred serious liabilities because of the nature of their products. The usual large size of the components has meant limited shipping radius, special-handling and hauling equipment, and special routing. The user of smaller subsystem assemblies would consequently mean fewer special-handling requirements and the economic feasibility of shipping greater distances.

Inventory. The modular producer or the traditional builder has not been able to carry an inventory for the following reasons:

1. Cost of product.

2. Cost of storage.

3. Low capitalization.

The producer of components and subsystems, on the other hand, would have much smaller product and storage costs, high capitalization, and a product not subject to the fad-type obsolescence; thus, he could carry an inventory.

Regional Product Variation. Regional and local change requirements in units need not be accommodated by different producers in each area. Subsystem assemblies will allow only those subsystems affected to be produced in the region, thus allowing transregional markets for the other subsystems.

Automation. Automation, which greatly reduces the cost of many manufactured products, can only be used on low-complexity products. Not only might building-system components and subsystems be suitable for automation, but they might be produced with unspecialized equipment that can be used for production in other fields.

Planning Function. It was maintained above that a planning function is necessary to any strategy which is to accomplish the concept. The planning function must be capable of the following:

1. Identifying users' needs.

2. Translating the needs into explicit physical requirements.

3. Identifying alternative physical solutions.

4. Evaluating these alternatives.

5. Translating the selected solution into some instructions which will result in the product.

6. Accomplishing all the above services rapidly and economically.

These are the services which an architect is trained to supply. Such services, as they are currently performed for a custom house project, involve the identification of hundreds of alternatives and the making of hundreds of decisions to integrate custom subsystems into a specific product. The process is obviously very expensive; however, costs do not vary in proportion to the cost of the product: a $ 20 000 product may cost nearly as much to design as a $ 40 000 product.

The ways in which design costs can be decreased include the following:

1. Limiting the number of decisions and/or tasks which must be executed; for instance, the use of standardized detailing, modular coordination, etc.

2. Predetermination of alternative physical solutions. This type of design aid involves the generation of many alternative solutions and/or partial solutions which can be sorted or assembled when a specific solution is required. Techniques for sorting may be combinations of one or all the following:

a. Pattern books.

b. Manipulatable 3-D models.

c. Automated simulations.

d. Manual or automated design sequences.[1]

3. Automated deterministic design procedures.

It should be remembered that the principal objective of this strategy is to accommodate variation and flexibility. It is not enough to design hardware which can be combined into variable and flexible products. There must be guidelines for assembling the various products; hence, the planning function is necessary for a planning function which will service the following:

a. A consumer who wants to build.

b. A consumer who wants to modify.

c. Professionals who are building for anonymous clients.

Strategy Requirements. This section is a list of strategy requirements. The reader will note that some requirements are related to some of the considerations which have already been discussed.

General Strategy Requirements. The requirements stated at the end of the introductory remarks and at the beginning of the next section are general strategy requirements.

Hardware Requirements.

1. Each subsystem must have at least three alternative sets of hardware. It can be demonstrated, logically and mathematically, that a substantial range of different products may be obtained from a limited group of standardized components. The reasoning is thus: building is an additive process; parts, assemblies, and components may be designed, produced, and combined into subsystems serving specific separate functions in a unit aggregation; several subsystems may be combined to produce a specific product; if each function may be served by several alternative subsystems, the combination of these subsystems in different ways will produce a large number of specific products. This combinatorial potential is more completely explained by Kurtz.[2]

---

1. An example of a pattern book used with a manual assembly program can be seen in Alexander, Christopher, and others, Patterns for Houses, Center for Environment Structure, Berkeley, 1970.

2. John Kurtz, Making of Living Places. Unpublished thesis, Carnegie-Mellon University, Department of Architecture, 1970.

He shows mathematically that a product which required 12 subsystems and has three alternative choices for each may be assembled in 521 441 different ways. In addition, he shows that three alternatives for each subsystem yields the greatest ratio of alternative sets of hardware to total combinations.

2. The hardware must be designed with an open systems concept. Dimensional and modular coordination must be used.

3. Jointing must be rationalized. The means of joining for final assembly should be simple, requiring few tools. The number of joint types must be minimized.

4. The size of components must be some fraction of the dimensions of a unit's subdivisions (rooms). This can be confirmed by exercises using the currently popular room-sized monolithic elements. The configurations and structural limitations of these elements inhibit room size and shape, placement of openings, and unit configuration possibilities.

5. Each subsystem must serve only one function and should be built of different components. This will insure that the replacement or modification of one subsystem has a minimal effect on the others. For example, the replacement of plumbing or electrical subsystems in conventional residential units can be accomplished only with the partial destruction of the partitioning subsystem.

Development Models. There are a number of development models published and/or otherwise available to us which detail parts or all of the development of the strategy above [D-1, D-2, D-3].

Problems in Strategy Development. The problems which appear in the strategy development are great. For many, there is no explicit documentation of how they may be solved. Four problems will now be discussed which are related primarily to hardware and the planning function. These problems are as follows:

1. How to make a usable statement of user needs.

2. How to identify and state the range of units and unit configurations.

3. How to develop a usable jointing strategy.

4. How to interface alternatives at the component or subsystem level.

User Needs. Some of the problems related to determining user needs have already been discussed. These problems include the following:

1. There are few adequate techniques for determining user needs and very little documentation of techniques or need statements. This deficiency is due in part to the state of the art in social sciences and in part to the small number of social scientists working in the area.

2. Users do not have explicit knowledge of their own needs. Most users, even when given time to study it, give needs related to misfits with their past or present environment and/or related to their highest aspirations. Probably the greatest difficulty a user has is in order ranking needs or performing tradeoffs after he has a minimal list. He is not accustomed to making explicit weightings to trade off.

3. Needs cannot be determined on the basis of normative populations and still result in a good fit between unit characteristics and user need profiles. Needs vary by household.

4. Needs of individual households change through time.

The above points indicate the difficulty of reliable assessing user needs. Nevertheless, information must be used in the design of hardware and the planning function. The hardware cannot be designed if the expected range of configuration is not defined; and such definition requires explicit knowledge about the needs those configurations are intended to service. There is by no means a satisfactory answer to this dilemma, but there are ways of looking at this problem.

The concept of minimum requirements is still useful. The question which must be asked is: What is included in each household's requirements? The answer changes through time as the aspirations of the population change. At present, the minimum requirements probably include the following:

1. Current-state-of-art technology solutions to physiological needs.

2. Others included are appropriate in the institutions task group objectives listing.

Minimum standards cannot be the sole input in a specific unit design.

We have recognized that each household is potentially different, and for this reason we want to be able to build a range of units. The concepts of range may be used to get a usable statement of needs. To make this concept operable, we do not need to identify all possible need profiles. What we need to know are the limits of the range and its texture. This concept may be studied as follows:

1. Develop a list of households according to number of household members, age distribution, and kinship relationship; e.g., traditional family/young/two adults-two preschool children; traditional family/old/two adults; single/young/one adult; commune/young/20 adults; three preschool children, etc.

2. Identify behavior pattern classification which may apply to each group. (Dean in Urban Housing has presented behavioral pattern classifications for the traditional family.)

3. Identify requirements which affect properties of units and configurations.

4. Construct a matrix which will relate the above three sets of classifiers. At the meeting of items from each of the sets indicate the limits of the requirements for the identified household.

5. This procedure will not give the need profile for a specific household. However, a reduction of the resulting matrices to eliminate redundancies will give an approximation of the limits and texture of the range for which it is being designed.

Configuration Vocabulary. This strategy cannot be developed without defining the range of configurations which must be made. Hardware cannot be developed to make more than one configuration reliable unless all configurations are defined. Despite the fact that architects (some with a problem-solving attitude) have designed a diverse range of units and unit aggregations, there is little explicit theoretical or empirical information on the topological or geometric properties of all units or unit aggregations. Formulation is necessary and can only be done efficiently by an iterative process: development of classifiers (topological, geometric, use-related physical properties) followed by an organization of documented buildings and repeat.

Standardizing Joints. Standardization of jointing is one of the requirements for effective implementation of open systems building. Unlike dimensional and modular coordination, very little information is available. The available information includes the following:

1. Documentation of specific joints.

2. Design procedure for specific types of joints in various materials.

A comprehensive study of jointing is needed which would:

1. Locate and present all the existing information on jointing technique.

2. Classify and compare the properties of respective techniques.

3. Develop methods for designing jointing systems for industrialized building systems.

<u>Design Compatibility</u>. Techniques for designing and testing the compatibility of components in subsystems and systems are not well developed for application to industrialized building. One attempt is an option graph technique [D-4]. This is one area in which NASA could be of assistance.

REFERENCES

D-1. White, J.C.: The Systems Approach — Steps in Generating a System. Industrialization Forum, vol. 1, no. 3, April 1970.

D-2. Editors of IF: Developing the Hardware of a Building System. Industrialization Forum, vol. 1, no. 3, April 1970.

D-3. Burham, R.C.: A Proposal for the Development of a Flexible Building System for Housing. Unpublished.

D-4. Luckman, J.: An Approach to the Management of Design. Design Methods in Architecture, George Wittenborn, Inc., New York, 1969.

☆U. S. GOVERNMENT PRINTING OFFICE: 1972—745-381/4041—Region 4